RESEARCH MONOGRAPH No. 1
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MANPOWER IMPLICATIONS OF PROSPECTIVE TECHNOLOGICAL CHANGES IN THE EASTERN CANADIAN PULPWOOD LOGGING INDUSTRY

BY
DUNCAN R. CAMPBELL
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PROGRAM DEVELOPMENT SERVICE
DEPARTMENT OF MANPOWER AND IMMIGRATION
CANADA

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FOREWORD

From time to time, it becomes evident that an industry is on the verge of a technological breakthrough. All our experience indicates that the ensuing revolution in ways of doing things will benefit many but will affect others adversely. Those who must deal with the opportunities and problems presented by such changes are faced with the difficult questions of what shape the changes will take, when they will come, and how best to take advantage of them.

Knowledge of the likely impact of future events is indispensable if we are to order affairs so that disruption is minimized and the benefits flowing from inventive activity are maximized. It is necessary, for instance, that our educational and training systems, our employment counselling systems, and our immigrant recruitment centres, have the information needed to conduct their current counselling and plan their future activities. Firms and workers must be able to plan their individual growth in the context of the more general events which will take place.

It is never, of course, possible to obtain the precise knowledge of future events which we would all wish to have. In its absence, we operate on the basis of more or less informed guesses about what the future holds. This is particularly true when the area of concern is related to technological change. The process of invention and innovation, despite the work done in the last decade or so, is still insufficiently understood. We still lack a comprehensive theoretical and empirical foundation for anticipating the course of technology.

This study was initiated in order to serve two purposes: to develop and test a framework for anticipating the effects of technological change; and to apply that framework to the pulpwood logging industry to derive material which would be useful, primarily for anticipating future training needs. Explicit forecasting of detailed occupational changes wrought by a still developing technology is, in the most real sense, a new field. This study is in the nature of an initial contribution to what will undoubtedly become a rapidly growing body of literature.

In this study, the authors attempt to estimate the direction of technological change in pulpwood logging, the rate at which changes will take place, and the occupational impact of the changes. In the final chapter, potential training needs, the pattern of labour displacement, and the potential sources of workers for training, are discussed.

Throughout, the authors have, quite properly, underlined the various limitations underlying the explicit estimates which are made. In many areas, the necessary data do not exist; in others, there is no body of experience on which to fall back in deriving the relationships. In such a situation, the only solution is to make the most reasonable available assumption. The numerical fulfillment of the forecast necessarily depends on whether the assumption is validated by time.

It is, of course, almost inevitable that some of the assumptions will not be borne out. Knowledgeable persons within the industry are uncertain or divided in their opinions as to which combination of several possible events is most probable. There is no reason to believe that persons outside the industry, even after extensive study, will necessarily make better judgments.

The assumptions and conditional forecasts presented here are the best which could be made on the basis of the information now available. A best estimate made three years hence might well be different. It is in the nature of a conditional forecast that, as conditions change, the forecast must also change.

Throughout the study, the various assumptions and intermediate steps have been made explicit so as to facilitate future reworking of the forecasts. In many areas, assumptions other than those made are clearly within the bounds of reason. The structure of the report is such that any who wish to employ alternative assumptions may recompute the results with a minimum of effort. This flexibility will also be of value a few years hence when it is possible to substitute facts for assumptions. The study should thus have a lifetime considerably greater than that of the assumptions embodied in it.

If the particular expectations of the study are correct, the pulpwood logging industry in Eastern Canada is about to undergo a massive change. New machinery will be introduced into logging at an increasingly rapid rate until after 1970. During the next ten years between 8,000 and 13,000 workers will be displaced from the industry while pulpwood production continues to expand.

The training needs tentatively indicated by the study are equally impressive. The occupational mobility of workers will make it necessary to train many more persons than will actually be working at any one time. The expected expansion in the number of operators of the various types of equipment and in the number of mechanics required to service them will create a need for training on a scale which the industry has not yet encountered.

J. P. Francis,
Director,
Research Branch

ACKNOWLEDGEMENTS

We are grateful for the invaluable assistance received throughout the preparation of the study from the Woodlands Section of the Canadian Pulp and Paper Association and, in particular, from Mr. E. T. Owens and Mr. C. R. Silversides. Officials of the pulp and paper companies, the Logging Research Associates, the Pulp and Paper Research Institute of Canada, several government departments, unions, and other organizations, all gave freely of their time in interviews and offered valuable comments on the working draft of the study.

Initial work and interviews were carried out during the summer of 1964 by Mr. Michael Landauer and Mr. Power. Subsequent research and analysis was carried out by the authors, who bear the responsibility for any remaining errors. The manuscript was edited and prepared for publication under the editorial supervision of Mr. R. A. Knowles, Editorial Section, Information Service.

Duncan R. Campbell
Edward B. Power
Ottawa
June, 1966

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Chapter I

THE DEVELOPMENT OF THE PULP AND PAPER INDUSTRY IN CANADA

Canada's pulp and paper industry, a major source of employment and export earnings, is a child of technological change.

Some form of flexible writing material has been used by man since ancient times, but the composition of the basic material has undergone considerable change. Scrolls made from papyrus gave way to paper made from rags. This, in turn, was superseded in the last half of the nineteenth century by paper made from wood fibres. However, paper can be, and has been, made from a wide range of fibrous materials. The choice among the many possibilities has been determined by the relative abundance of the various raw materials, the nature of the demand for paper products, and the available technology.

It was the second great shift—from rag waste to wood fibre—that laid the foundation for what is now Canada's major forest industry. Because the materials used for papermaking until the 1860's were primarily linen and cotton rags, the paper industry was oriented toward the large population centres of the world, which both produced the rag waste and consumed the paper. With the invention of the soda process for chemical pulping in 1854 and of the mechanical groundwood process in the early 1860's, the raw material basis of the industry was completely altered. The chief requirement now became a matter of access to cheap supplies of wood of a type suitable for pulping. The other major pulpmaking processes—the sulphite process, introduced into Canada in the 1880's, and the sulphate process, introduced shortly after the turn of the century—permitted the production of a wider range of high quality papers from the available wood fibre.

Despite the shift in the raw material basis of the industry, Canadian production continued to be primarily geared to the domestic market during the latter part of the nineteenth century. The pressure of demand on world pulpwood resources for newsprint and other paper was not sufficiently great to overcome transportation and tariff penalties, and most industrial nations were substantially self-sufficient. The market for highly advertised, mass produced, consumer products had not yet developed and the newspapers of the day were smaller and thinner than the modern versions.

The increasingly rapid growth of demand, particularly for newsprint, and the consequent depletion of cheap pulpwood sources close to major markets, brought about a gradual alteration in international cost patterns. Expectations of increasing disparity between Canadian and American wood costs brought pressure from American publishers for duty-free admission of Canadian newsprint. This became a reality with the tariff change of 1911.[1] In 1913, the United States granted duty-free entry to wood pulp as well, partly to eliminate the discrimination against domestic U.S. newsprint mills inherent in taxing the intermediate raw material but not the finished product.

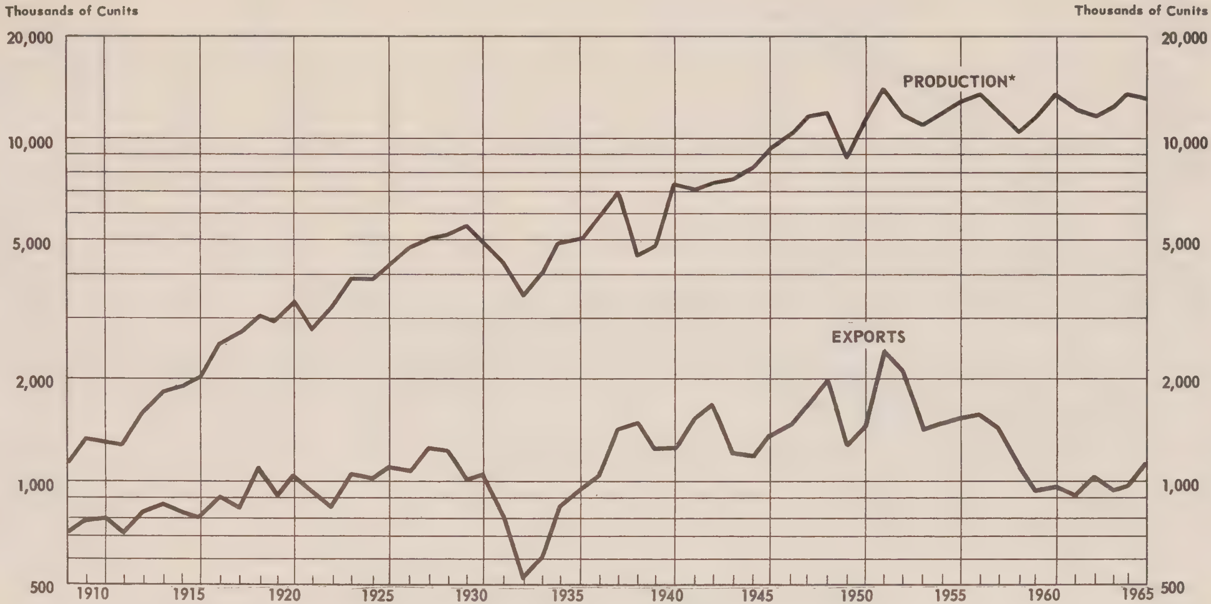
The effect of the technological revolution in papermaking, combined with immense volumes of cheap wood of a suitable kind, and duty-free entry to the world's largest newsprint markets—the United States and the United Kingdom—was to completely alter the structure and orientation of the Canadian industry. Canada's first paper mill, built in Lachute, Quebec, in 1805, had been followed by similar ventures. By 1851 there were 10 mills in Upper and Lower Canada all using linen and cotton rags to make paper for the domestic market. Starting with a groundwood mill at Valleyfield, Quebec, in 1869, the number of mills using pulpwood grew rapidly. By 1911, when the tariff change was introduced, Canada had 72 mills. The production of pulpwood to supply the mills grew from 221,000 cunits in 1891 to 570,000 in 1901 and had reached 1,819,000 cunits in 1911.[2]

In the years following the tariff change, the Canadian industry continued to expand at a rapid pace. As Figure 1 shows, the volume of pulpwood produced in Canada almost doubled from 1.9 million cunits to 3.4 million cunits in the six years following 1914, and reached 5.6 million cunits by the time the great depression arrived in 1929. Since then, growth, while still considerable, has proceeded at a more moderate pace. The growth of pulpwood production and residue consumption since 1951 has been slower than between 1929 and 1951. This has only been partly attributable to the decline in pulpwood exports (also shown on Figure 1). Over the entire period since the beginning of the First World War, exports have grown more slowly than domestic consumption, as a higher percentage of pulpwood cut was converted to pulp in Canada. Since 1951, of course, there has been substantial absolute decline in the level of pulpwood exports.

Another reason for the relatively slow growth in Canadian pulpwood production since 1951 has been a very rapid increase in the use of chipped wood residue. This residue consists of sawmill and other waste material which is chipped and transported to pulp mills for use. As Figure 2 shows, however, the growth rate of pulpwood production would have been slower since 1951 even if residue had not been substituted for pulpwood. Rapid

Figure 1

PULPWOOD PRODUCTION AND EXPORTS
CANADA, 1908–1965

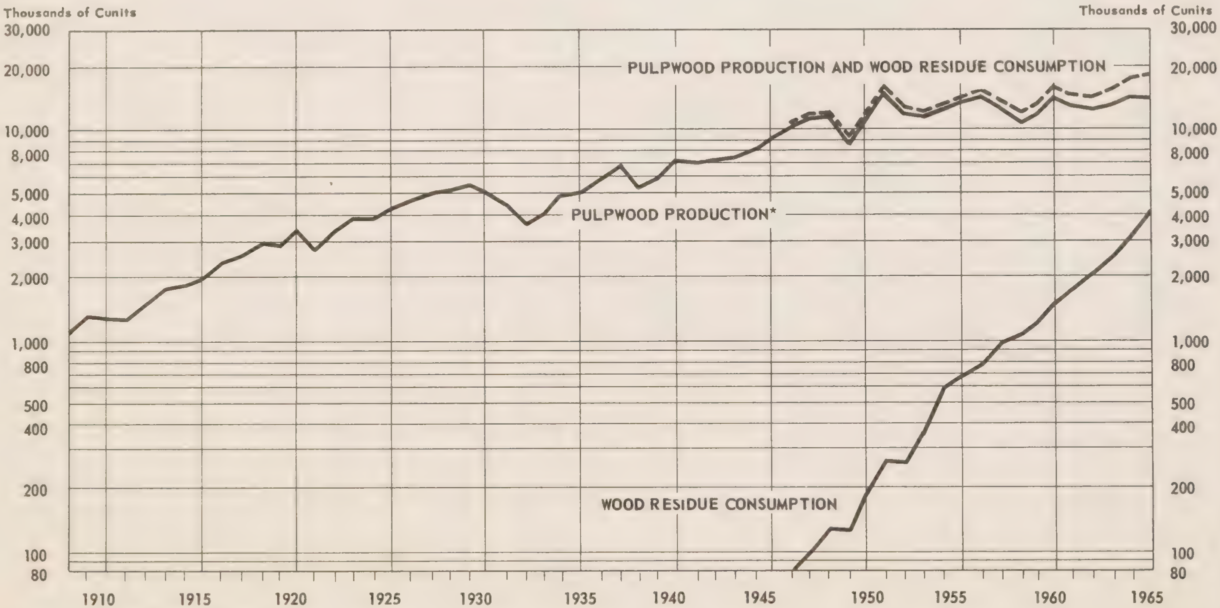


*Estimate for 1965.

Source: *D.B.S.,* **CANADA YEAR BOOK,** *1929; D.B.S.,* **PULPWOOD AND WOOD RESIDUE STATISTICS,** *December 1961–December 1965; D.B.S.,* **TRADE OF CANADA, EXPORTS BY COMMODITIES,** *December 1964 and October 1965; Urquhart, M.C. and K.A. Buckley (Editors),* **HISTORICAL STATISTICS OF CANADA,** *1965; and CPPA,* **REFERENCE TABLES,** *1961–1963.*

Figure 2

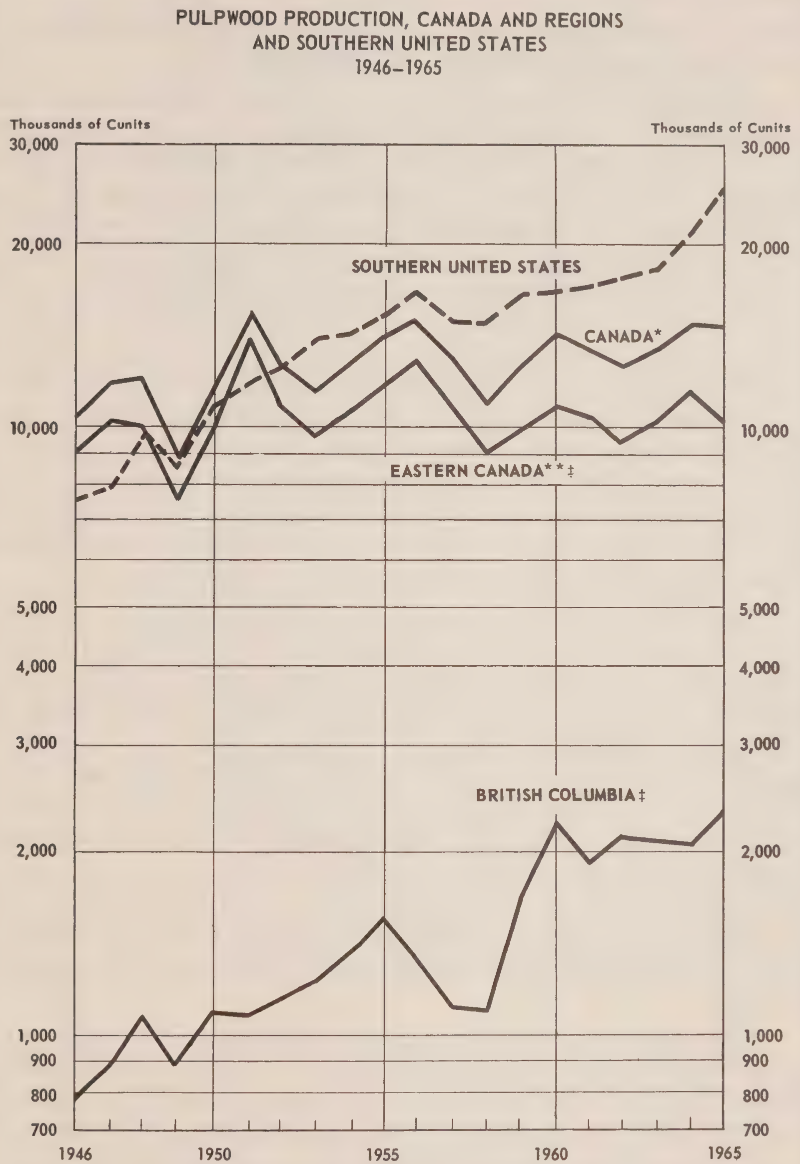
PULPWOOD PRODUCTION AND WOOD RESIDUE CONSUMPTION
CANADA, 1908–1965



*Estimate for 1965.

Source: *D.B.S.*, **THE PULP AND PAPER INDUSTRY,** *1930–1962; D.B.S.*, **CANADA YEAR BOOK,** *1929; D.B.S.*, **PULPWOOD AND WOOD RESIDUE STATISTICS,** *December 1961–December 1965; Urquhart, M.C. and K.A. Buckley (Editors),* **HISTORICAL STATISTICS OF CANADA,** *1965.*

Figure 3



**Includes Ontario, Quebec, New Brunswick and Newfoundland. *Estimate for 1965.
‡Production for consumption only in 1965.

Source: *D.B.S.*, OPERATIONS IN THE WOODS, *1946–1962 and* PULPWOOD AND WOOD RESIDUE STATISTICS, *December 1963–December 1965; Miller Freeman Publications, Incorporated (Connecticut),* PULP AND PAPER, *July 22, 1963; U.S. Department of Agriculture, Forest Service,* SOUTHERN PULPWOOD PRODUCTION, *1963 and 1964, and* THE DEMAND AND PRICE SITUATION FOR FOREST PRODUCTS, *1965.*

growth of pulpwood production in the Southern United States (Figure 3) has also held Canadian pulpwood production down.

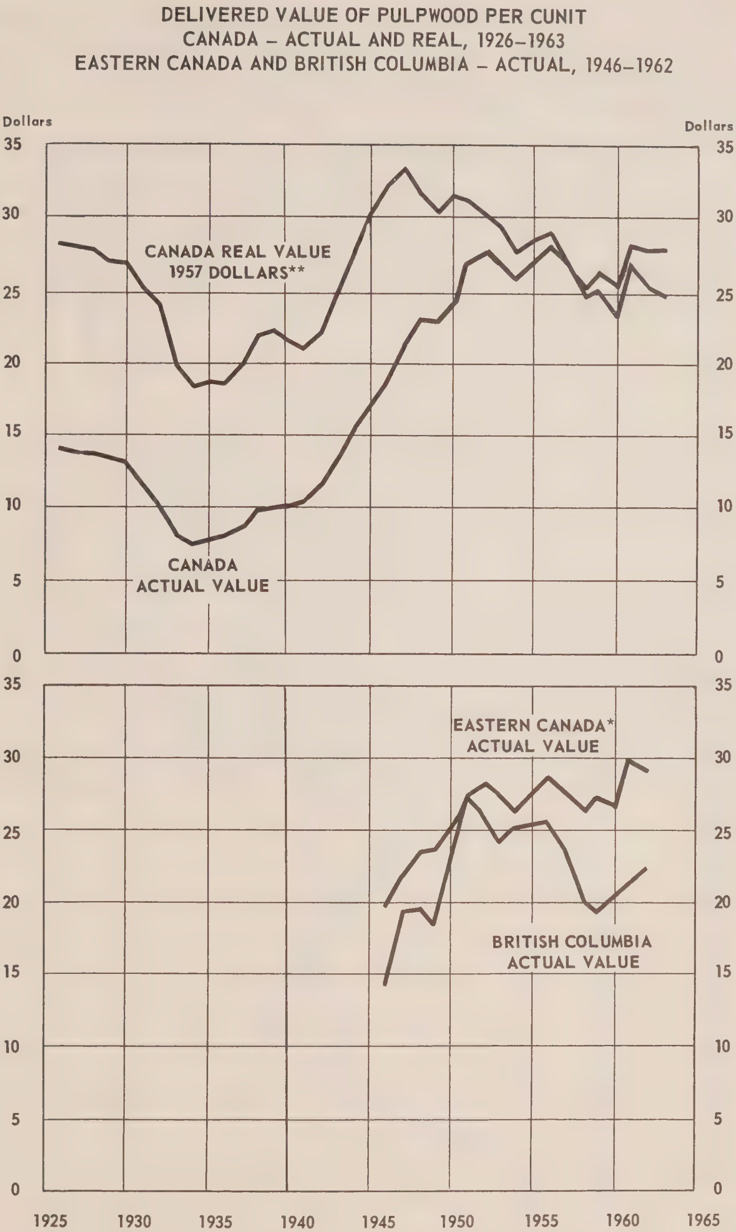
Although the effect of these factors has been to make negligible the overall growth of Canadian pulpwood production between 1951 and 1965, this has not been true of all regions of Canada. Production in British Columbia, as Figure 3 shows, has more than doubled between 1951 and 1965. The reasons for this have been ready access to rapidly growing West Coast markets and highly favourable harvesting conditions such as large diameter trees. These favourable conditions are reflected in the relative costs of production of pulpwood in the East and the West. As Figure 4 shows, costs have been significantly lower in British Columbia than in Eastern Canada.[3] The very different terrain and stand conditions in British Columbia have served to create an industry which differs markedly from that in the East not only in costs and growth, but in technology and work methods as well. Even the occupational categories of woods workers are different in British Columbia. Although the end product of the harvesting process is the same, in a technological and manpower sense Canada has not one but two pulpwood logging industries.

Historically, the Eastern Canadian logging industry had been notable for a near absence of technological change since its birth in the nineteenth century. Then, axes and hand saws were used for cutting; hauling was done by horses; long-distance transportation was typically by water. While the pulp and paper producing segment of the industry made one technological advance after another, the logging industry remained dependent on the muscular power of men and animals. This technologically sleepy industry began to stir about the time of the Second World War, and since that time the pace of change has been increasingly rapid. The power saw has reduced the human effort involved and the various tractors and wheeled skidders are now driving out the horse. Transportation systems have also changed—nearly 25 per cent of all Canadian pulpwood is now transported to the mill by truck.

The combination of little or no growth in output and rapid technological change made for drastic reductions in the work force needed for pulpwood logging. As Figure 5 shows, employment on company limits east of the Rockies declined from 2,784 thousand man-weeks in 1951-52 to 1,442 thousand man-weeks in 1964-65. The other side of the coin has already been reflected in Figure 4—the fact that the cost of pulpwood has fallen relative to the cost of the other goods and services which go to make up our gross national product.

It is apparent that this now progressive industry is on the verge of a further technological revolution. In recent years, considerable sums of

Figure 4



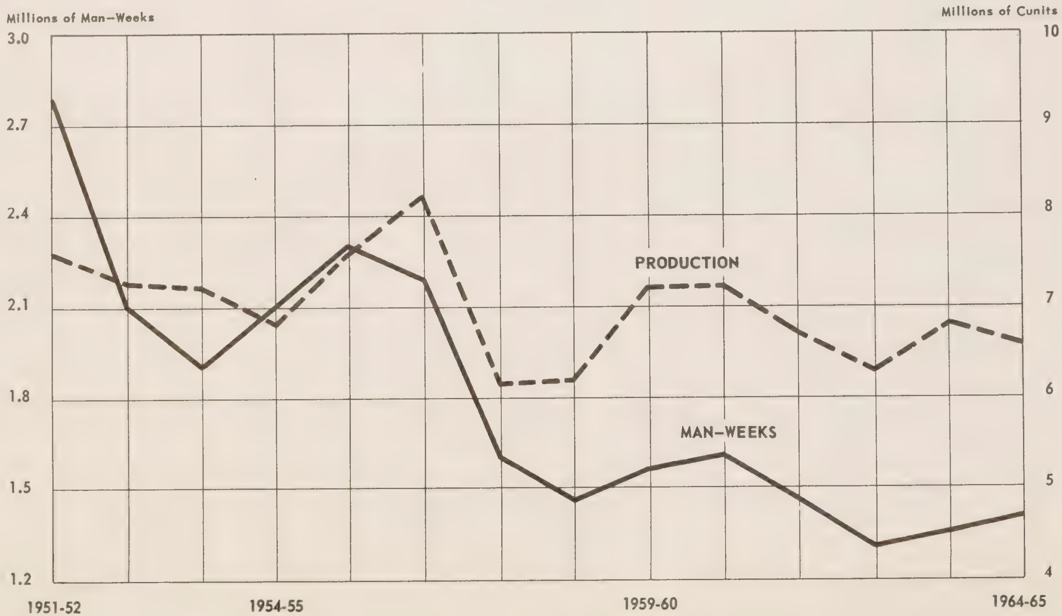
*Includes Ontario, Quebec, New Brunswick and Newfoundland.

**Real figures calculated by dividing actual values by GNE price deflator.

Source: Urquhart, M.C. and K.A. Buckley (Editors), HISTORICAL STATISTICS OF CANADA, *1965; D.B.S.,* OPERATIONS IN THE WOODS, *1946–1962; CPPA,* REFERENCE TABLES, *1965.*

Figure 5

MAN-WEEKS WORKED, ALL EMPLOYEES, AND PULPWOOD PRODUCTION ON COMPANY LIMIT OPERATIONS
EAST OF THE ROCKIES
1951–1952 TO 1964–1965



Source: Estimated limit pulpwood production East of Rockies, based on data supplied by CPPA and D.B.S.; and man-weeks statistics compiled from CPPA, Woodlands Section, **WEEKLY SUMMARY OF THE LABOUR SITUATION,** *June 1951–May 1965.*

money have been invested in research to develop new and fully mechanized logging methods which will drastically reduce labour requirements. It is evident that these dynamic changes will also create entirely new occupations in which it will be necessary to train workers. The following chapters are intended to assist in the understanding and interpretation of these potential developments. The present nature of the industry, from a manpower and technological point of view, is described in Chapter II. Chapter III discusses the characteristics of the new technologies. Chapters IV and V deal with the expected timing of introduction of the new equipment and its impact on employment by occupation, training needs, and seasonality.

REFERENCE NOTES

1. The role of provincial export embargoes on pulpwood cut from Crown land in this development is not entirely clear. See the Royal Commission on Canada's Economic Prospects, *The Outlook for the Canadian Forest Industries,* 1957, pp. 88-90, for a more comprehensive discussion of the restriction involved.
2. One cunit equals 100 cubic feet of solid wood. The traditional unit of measure, a cord, contains 85 cubic feet of solid wood.
3. The data in Figure 4, it should be noted, are not true cost figures. They are highly dependent on values reported by mills for pulpwood which does not pass through the market. Thus the figures are, in large part, based on accounting values which are dependent on the price at which integrated concerns chose to transfer material from one department to another. For a discussion see the Royal Commission on Canada's Economic Prospects, *The Outlook for the Canadian Forest Industries,* 1957, p. 191. Whether the apparent widening in relative costs reflects the true situation or mere accounting changes is unknown. Clearly, the data should be treated with caution.

Chapter II

CURRENT LOGGING METHODS AND RECENT CHANGES

Advances in logging technology since the Second World War have brought about significant changes in methods of harvesting pulpwood resulting in extensive increases in productivity. These changes have not occurred to the same degree or in the same manner in all operations, consequently, a wide variety of methods are currently employed. In order to understand the impact which the advanced equipment now being tested is likely to have, it is necessary to examine present methods of production and to derive some idea of the still continuing post-war changes and their impact on the industry.

The discussion in this and subsequent chapters is largely restricted to those operations which are conducted on the Crown limits of the large integrated concerns. These "company limit" operations have, since the Second World War, accounted for about two-thirds of total pulpwood production east of the Rockies. The remaining one-third of the production in this area comes from a mixture of farmers, small-woodlot operators, larger freehold operators, and some smaller operations on Crown lands. Statistical data on this miscellany of non-limit operations are meagre and sometimes conflicting. In view of the difficulty of determining with any precision the type or amount of labour input used in these smaller operations and, since it is expected that almost all the manpower effects of the new equipment will occur on the larger operations, only the latter are covered in detail.[1] A short discussion of non-limit operations is presented at the end of the chapter.

Pulpwood Logging Operations

The two-thirds of all eastern pulpwood which comes from company limits—and, indeed, the one-third which does not—are harvested under a wide variety of environmental conditions and by many different methods. The basic operations which must be performed on trees are, of course, common to all methods and it is necessary to review them briefly before describing the actual systems themselves.

The several operations involved in pulpwood processing are illustrated in Figure 6, but it must be realized that they are not necessarily performed in the indicated order. The first operation—the actual severing of the stand-

ing tree from its base with a power saw, buck saw, or axe—is called *felling.* Next comes *limbing*—the removal of the branches. In the *topping* operation, that part of the tree top which is considered by the cutter to be too small for pulpwood is removed. The branches plus the tree top, collectively referred to as *slash,* comprise between 5 and 45 per cent of the tree weight.[2] In the *bucking* operation, the tree length is cut into pieces or bolts of desired length—usually a nominal 4 feet or 8 feet (actually 50 inches or 100 inches including trimming allowances). *Scaling* is the fifth operation. Most of the pulpwood cutters are remunerated on a piece-rate basis (i.e., a rate per unit produced) and the wood of individual cutters is scaled and recorded separately for payment. In the sixth operation the bark is removed from the pulpwood bolts. *Barking* can be performed either in the woods or at the mill, but it has been generally carried out at the mill.[3] The bark represents between 5 and 20 per cent of the tree weight.[4] *Chipping* the bolts of pulpwood is the seventh operation. Thus far, this has been done almost entirely at the mill but chipping in the woods is currently under investigation by the industry.[5]

Any movement of wood from the stump to the mill is usually referred to as transportation. However, for purposes of this report the term transportation will be limited to the conveyance of wood from the stump to a landing (including handling at both the stump area and the landing place). The problems which present themselves in the movement of wood from the final landing to the mill parallel those in long distance transport of many other bulk commodities and although important to the industry are largely outside the scope of this report.

The term "stump" denotes the area where the standing tree is felled. The "final landing" is the point where the long-distance movement of the pulpwood by rail or water (or occasionally by special long-distance trucks) to the mill begins.[6] Usually the point of transfer is at a railway siding or on the bank of a stream or body of water. An "intermediate landing" is a point where pulpwood is transferred to trucks for transport to the final landing or the mill. Hence, the expression "roadside landing" usually refers to an intermediate landing. The pulpwood is transported from the stump area to the intermediate landing by means of a machine or a horse.

The stump to intermediate landing phase of the pulpwood production process (which is called the "logging operation") accounts for approximately 75 per cent of the total pulpwood production costs, i.e., just over one-quarter of the cost of producing pulp and paper. All of the processing operations, except barking and chipping, are normally carried out in this phase. The large share of total costs involved, the wide variety of environmental conditions encompassed, and the relative lack of mechanization,

Figure 6.
Pulpwood Processing Operations

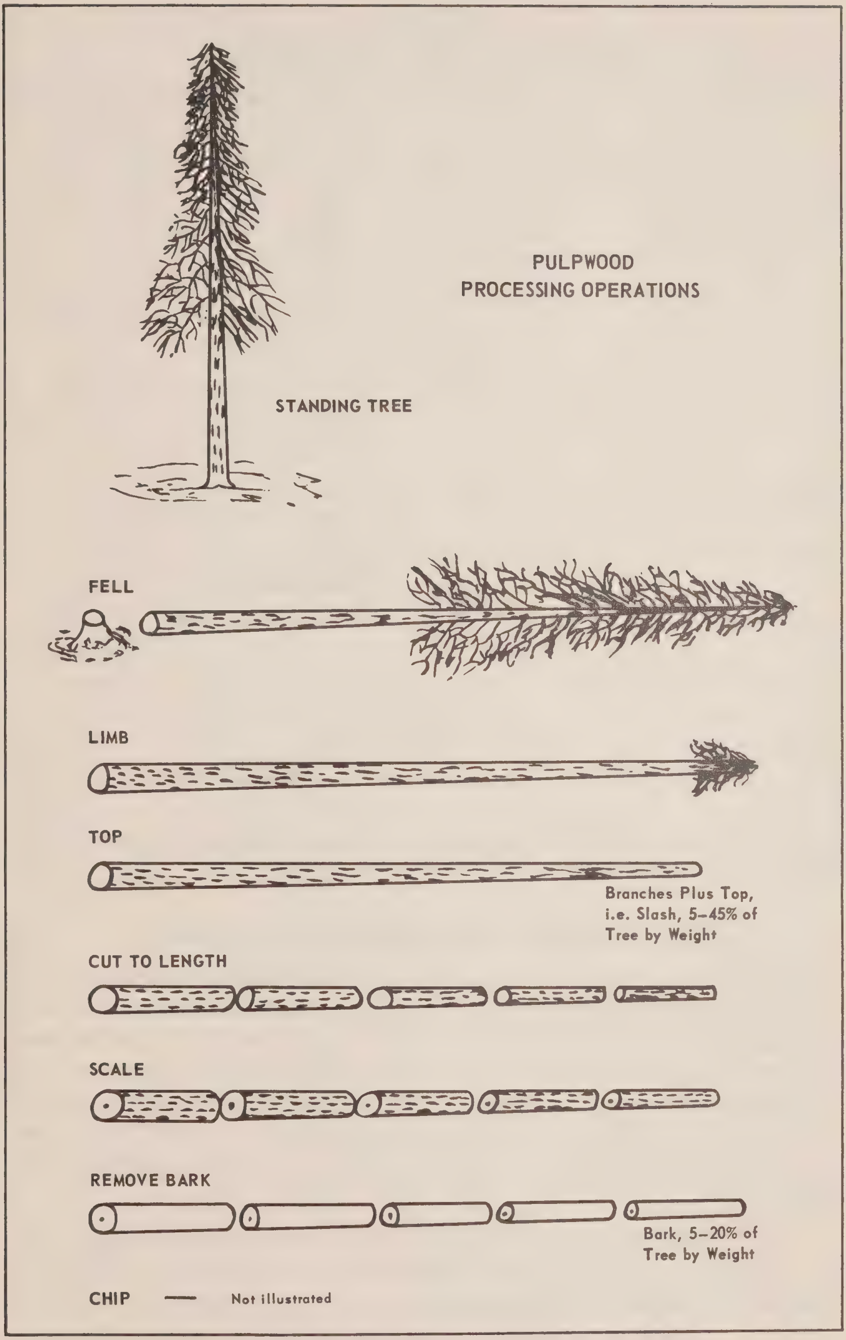


Figure 7.
The Three Pulpwood Logging Systems

Area	Short-Wood	Tree-Length	Full-Tree
Stump	Fell Limb Top Buck (Bark)	Fell Limb Top (Bark)	Fell
	Forward or skid	Skid	Skid
Landing	Transfer to long distance means of transport	Buck (Bark) (Chip) Transfer to long distance means of transport	Limb Top Buck (Bark) (Chip) Transfer to long distance means of transport
Pulp or paper mill			

combine to make this phase of the production process a source of difficulties but also provide opportunities for cost reduction.

Conventional Methods of Pulpwood Logging

Pulpwood logging methods can be, for analytical purposes, grouped into three general logging "systems"—short-wood, tree-length and full-tree (see Figure 7). Of these, only the short-wood and tree-length systems have been widely used in Eastern Canada. Even within these two systems, however, many distinct specific methods of harvesting wood are used. In an analysis of logging operations in Eastern Canada in 1956-57, W. D. Bennett was able to distinguish no less than 148 different conventional logging methods.[7]

The particular system and method which it is most profitable to use on a given operation will be that which produces the lowest combination of processing, handling, transportation, camp overhead, and mill costs per unit. The variables encountered in logging operations are multitudinous

and it is evident that no one method is or can be the least cost method under all environmental conditions.[8] Local stand, soil and topographic conditions all prevail, to a greater or lesser degree, upon the choice of a logging system and of a logging method.

In logging, as in other raw material processing operations, there are two general but opposing routes to lower costs. On the one hand, greater processing efficiency can usually be achieved by the centralization of specialized large-scale processing facilities operated on a continuous basis. In logging operations, this indicates processing as close to the final delivery point as possible because the concentration of wood fibre increases in size as the wood is moved from the stump to the pulp or paper mill. On the other hand, transportation costs can be lowered by eliminating as early as possible all unmerchantable by-products and thus reducing excess weight and bulk. Consequently, the removal of branches, tree top and bark as soon as possible is desirable. The problem is to minimize the combined processing and transportation costs (including cost of property development to provide access to standing timber and delivery routes to the final landing) under the wide range of environmental conditions found in the woods.

Although there is much variety within the approximately 75 short-wood methods, they have a number of common features. A pulpwood cutter, equipped with a high-speed power saw, cuts the tree down, cuts off the top and branches, bucks the tree-length, and piles the bolts either at the stump or at a logging roadside (such as a strip road). The nominal length of the bolts is generally 4 feet, 8 feet or 12 feet. The bolts of wood are hauled out by horse, tractor or, increasingly, by skidder to an intermediate transfer point (the "landing") or directly to the long-distance transporting medium (train, truck or water).

The majority of conventional short-wood operations are based on the 4-foot bolt, although Ontario and Quebec operations have been shifting to the 8-foot bolt. Most Ontario short-wood operations are now based on the 8-foot bolt, but the 4-foot bolt is still most widely used in Quebec. In Newfoundland and New Brunswick, the 4-foot bolt is standard, and there is no apparent trend towards the longer bolts. There is also considerable variation between areas in the method of moving the pulpwood. Horses and tractors continue to be the dominant methods of transporting wood to landings in Quebec and the Atlantic region, but in Ontario the horse has virtually disappeared and skidders have taken over most of the burden of moving wood. However, the volume of wood moved by skidders has increased rapidly in Quebec and is rising sharply in the Atlantic region.

In the commercial application of this system to date, all the purely processing operations have been performed manually except for use of the

power saw and, sometimes, mechanical barking equipment. Aside from the introduction of the power saw about 1950, the most noticeable attempts to increase efficiency have been in the handling and transporting phases. Forwarding machines, which carry the bolts of pulpwood from the stump area to the landing, and mechanical loaders, which pick up the wood at the landing and load it—usually onto a truck—are being used extensively. The high-cost factor in this system, however, has been the manual processing and handling at the stump. Attempts to mechanize stump area processing operations have not been completely successful as yet, partly because of difficulty in satisfying the conflicting requirements of a high rate of continuous processing and high mobility.

The newer tree-length system—now in common use—reduces the number of operations performed by the pulpwood cutter. The cutter, using a power saw, fells, limbs and tops the tree. A wheeled tractor, horse or crawler tractor moves through the woods, collects a number of tree-lengths, and hauls them to the landing where a man with a power saw cuts them into the desired lengths. The logs may be barked prior to being transported to the mill.

The use of the tree-length system has increased rapidly because of the progressive improvements in the equipment available for use in the system. Light skidders moving on wheels or tracks are rapidly replacing the horse as a mover or wood from the stump to the landing. High-capacity slashers are used, in some cases, to buck the tree lengths at the landing. Most of the wood processed by the tree-length system, however, is still bucked by chain saws.[9]

In the full-tree system, the only operation performed at the stump is felling. The full tree—with its branches and top still attached—is skidded from the stump to the landing for the other processing operations. This high concentration of wood and processing operations at one point allows the system to use semi-stationary, high-capacity equipment to perform a greater variety of operations than is possible with the other two systems. The significant drawback, of course, is the extra cost involved in transporting largely unusable slash to the landing. Although extensive testing has been carried out, the full-tree system has not yet been used on a full-scale commercial basis in Eastern Canada.

No very precise determination of the degree of utilization of the two currently used systems is possible. Appendix Table D-1 presents survey data collected between 1957 and 1965 on the percentage of wood cut to various lengths in Eastern Canada. For the reasons outlined in the Appendix, these data seriously underestimate the increasingly widespread use of the tree-length system. Competent industry sources suggest that realistic

estimates would show that tree-length operations accounted for close to 45 per cent of all company limit pulpwood cut during the 1964-65 season. Most of the understatement occurs in areas other than Ontario, where the 57 per cent tree length quoted in the table is believed to be representative. Appropriate figures for Quebec and the remainder of Eastern Canada would be about 40 per cent and 35 per cent, respectively.

Regardless of the precise level of tree-length operations at the moment, the general pattern over the last few years is clear. The tree-length system has been rapidly ousting the traditional short-wood system. Ontario has led the way in this development with Quebec and the Atlantic region trailing behind. However, it is not possible simply to extrapolate this trend into the future. The rapid growth of the tree-length system has been caused largely by the present degree and nature of woods mechanization. It is almost certain that the nature and extent of woods mechanization will be radically different in the future.

The short-wood and tree-length systems, as currently applied, involve a vastly greater degree of mechanization than was utilized in the logging methods prior to the Second World War. The power saw, the crawler tractor and the new tracked or wheeled skidder have greatly increased man-hour productivity in the Eastern Canadian woods. The adoption of mechanical loading equipment, the use of high-speed slashers and the increased use of better adapted trucks have combined with these more spectacular developments to produce the evolving industry which can be observed in the woods today.

There is, however, another important factor in improving productivity which is much more difficult to measure or even to discuss qualitatively. This factor is management. Although no proof can be offered, it seems reasonable to suppose that much of the responsibility for improvements in the efficiency of forest operations belongs to management. Just as there is increasingly a new breed of worker—the "professional logger"—so there appears to have been a shift in the nature of woods management. It is quite evident that the post-war years have seen the devotion of much more effort to management methods, to measuring the results of different methods of operation, and to adopting those methods which appear to be most promising. The results of this change are expressed in many small ways, such as a decision to adopt cafeteria service in camps—or in large, discrete changes such as a shift from conventional short-wood to tree-length methods.[10]

The overall degree of logging mechanization can best be summarized by examining the level of horsepower days used per man-day. Measured in this manner, the degree of mechanization increased more than fourfold

between the 1950-51 and 1959-60 logging seasons.[11] This rapid increase from 5.9 horsepower days per man-day to 26.5 horsepower days per man-day was the result of a tripling of worked horsepower days and a one-third decline in man-days worked. During the period, total man-days declined from just under 11 million per year to just under 7 million, despite a small increase in the volume of wood cut.

The increases in horsepower utilized were spread across the spectrum of equipment (see Table 1). Although the increase in some types of equipment (e.g., power saws) was vastly greater than average, it seems evident that the main factor at work was an increase in investment per worker on a broad range of equipment. There were also significant improvements in equipment—frequently in the form of fitting machinery used in other industries more closely to forestry needs.

As noted earlier, there appears to have been little mechanization and, indeed, little technological change in the industry prior to the Second World War. Trucks were used on many operations, but not to the degree which is now current. Power saws had appeared in isolated instances, but were heavy and lacking in reliability. Skidding was the domain of the horse and cutting and piling were carried out by means of manual labour.

Technological developments during the Second World War paved the way for the development of a light, reliable power saw to supplant the axe and buck saw, but it was not until the early 1950's that they began to be used in the Eastern Canadian woods in any considerable volume and by 1957-58 they had become a pervasive piece of equipment in pulpwood processing. These saws, which are largely owned by the cutters rather than the companies, have a life span of about two years.[12] They have substantially increased productivity in the limited range of operations for which they are used but, because other operations bulk larger in terms of work time consumed, the impact of the power saw on overall productivity has been limited.

The period since 1950 has also witnessed a progressive movement from horses to tractors and then to skidders. As Table 1 shows, the number of tractors increased from 1,496 in the 1950-51 season to 2,574 in the 1960-61 season. Although data are not available, there is no doubt that the number of horses used on operations underwent a considerable decline. To some degree tractors were, and are, used for operations such as road building, but in many instances they replaced horses as movers of wood to landings. This appears to have been caused both by the superior performance of tractors and a decline in the availability of horses—related to the declining use of horses on farming operations.

Table 1. Mechanical Logging Equipment Used on Pulp and Paper Company Limit Operations in Eastern Canada in the Logging Years 1950-1951 and 1959-1960

Machinery	1950–1951					1959–1960				
	Number of Machines	Estimated Average h.p. Rating	Estimated Average Working Days (8 hours) per Year	Worked h.p. Days		Number of Machines	Estimated Average h.p. Rating	Estimated Average Working Days (8 hours) per Year	Worked h.p. Days	
				Total	Per Cent				Total	Per Cent
Tractors	1,496			11,922,000	18.3	2,574			22,266,000	12.1
Small crawler	99	35	100	297,000	0.5	620	35	190	4,120,000	2.2
Large crawler	895	65	160	9,293,000	14.3	1,304	80	116	12,166,000	6.6
Rubber belt	340	100	60	2,040,000	3.1	453	100	90	4,080,000	2.2
Small wheel	162	30	60	292,000	0.4	96	30	100	288,000	0.2
Large wheel	–	–	–	–	–	101	100	162	1,612,000	0.9
Trucks	3,305	105	110	38,404,500	59.0	5,774	130	143	107,192,000	58.2
Automobiles	222	100	120	2,660,000	4.1	281	150	300	12,600,000	6.8
Buses	47	115	310	1,670,000	2.6	147	150	200	4,400,000	2.4
Cranes, yarders, winches and loaders	186	100	105	1,900,000	2.9	339	100	133	4,504,000	2.5
Graders, plows, crushers, compressors, welders	212	100	45	955,000	1.5	381	100	89	3,376,000	1.8
Slashers	20	50	90	292,000	0.4	20	100	180	360,000	0.2
Power saws	?	3	?	578,000	0.9	?	5	?	15,150,000	8.2
Other*	–	–	–	6,343,000	10.3	–	–	–	14,558,000	7.8
Total				**64,999,500**	100.0				**184,436,000**	100.0

*Includes tugs, outboard motors, scows, generators and stationary engines.

SOURCE: Koroleff, A. M., *New Approach to Collective Work Evaluation of Machinery Aggregations*, CPPA, Woodlands Section Index No. 2051 (B-1), August, 1961.

Table 2. Number of Rubber-Tired Skidding Tractors on Pulpwood Logging Operations in Eastern Canada*, 1959-1965

Year	Number
1959	24
1960	62
1961	115
1962	165
1963	453
1964	1,003
1965	2,160

*Eastern Canada includes Ontario, Quebec, New Brunswick, Nova Scotia and Newfoundland.
SOURCE: C. R. Silversides, Abitibi Paper Company Limited, Toronto.

The switch to skidders has come about almost entirely since 1959. As Table 2 shows, the number of skidders has risen rapidly from 24 in 1959 to 2,160 in 1965. The skidder is much better adapted for moving wood than the tractor. Its articulated frame makes it much more versatile than the conventional crawler tractor and permits it to traverse rough terrain with comparative ease. The skidders are primarily used to skid tree-lengths from the stump to the landing. It is estimated that there are about 600 such skidders in Ontario, 900 in Quebec, and 660 in the Atlantic provinces. The use of skidders is currently increasing rapidly and industry estimates suggest that the number of skidders should reach its peak of about 6,800 in 1969.

Effects of Past Mechanization

It has not been possible within the scope of the present study to isolate the effect of post-war mechanization on the industry. A large number of changes have taken place within the industry during the post-war years but without much more work than has been undertaken it is impossible to determine separately the effects of these changes. Changes in work methods and in the nature of the labour supply have occurred throughout the period. At the same time, there have been very big changes in productivity, hourly wage rates, occupations, seasonality, and turnover.

In some of these areas the causal connection is direct: the relationship between mechanization and productivity and between mechanization and occupational changes is obvious. The change in productivity is a major determinant of changes in wage rates and labour costs per cunit. Changes in seasonality and turnover are, however, more complex and may be more strongly related to other factors such as the changing nature of the in-

dustry's manpower supplies. Accordingly, the "results" of past technological changes are discussed with little or no comment, except where the causal connection seems plain.

The Rise in Productivity

Productivity changes can be measured conceptually in a number of ways. One can measure output per man-hour, per man-day, per man-week, etc. This computation can be performed on the basis of all workers employed or it can be restricted to various groups of workers—for example, production workers.

The nature of the productivity measures used here has been determined mainly by the form in which data are available. Figure 8 shows indexes of output per man-hour, based on 1954-55 = 100, for non-salaried staff on the company limit operations east of the Rockies.[13]

The graph shows a general productivity increase of about 58 per cent east of the Rockies over the eleven years, for an average increase of almost 4.3 per cent compounded annually. As the confluence of the regional indexes shows, the increase has been quite general. The figure suggests that productivity growth may have been more rapid prior to 1959-60 than since that date, but this must be qualified. Considering the difficulties inherent in deriving reliable productivity figures—which have by no means been overcome by the procedures used here—and the inexplicable variations which occur in some years at the beginning and end of the series, no such decline in the rate of growth of productivity can be considered to have been documented.

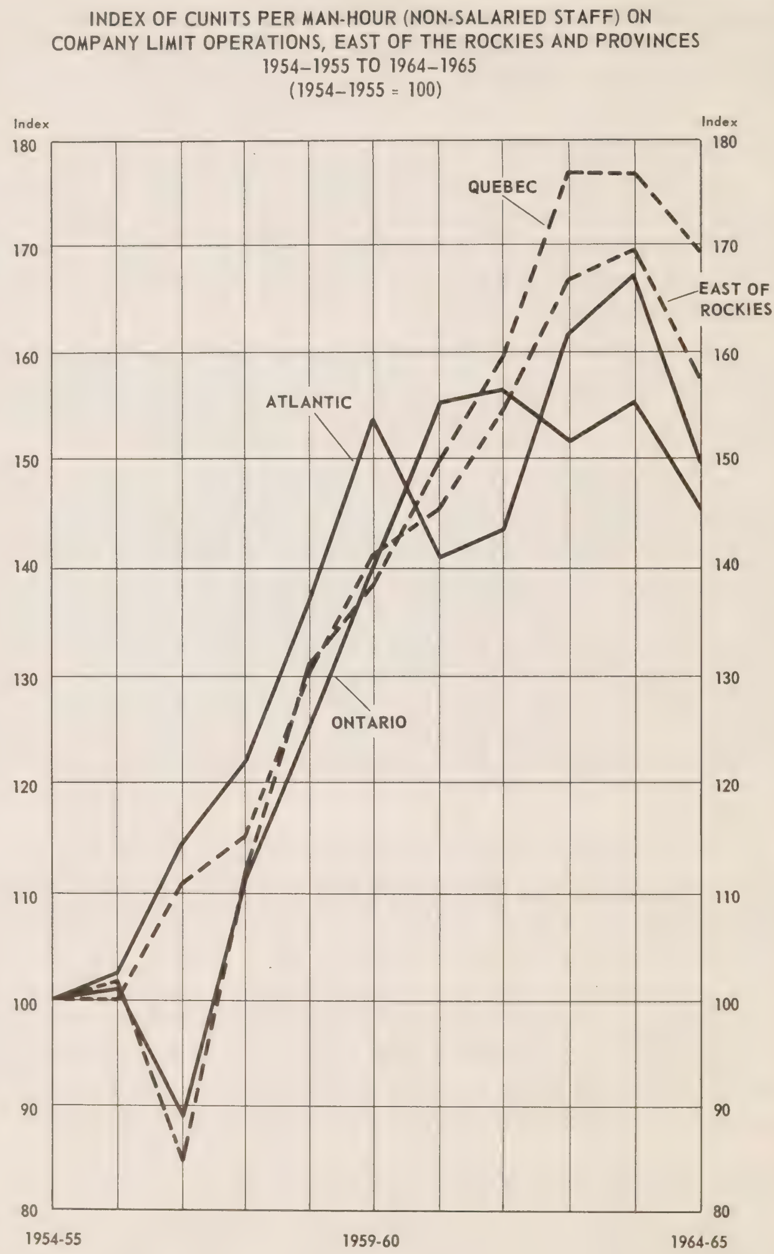
Output per total worker man-hour increased by 52 per cent over the eleven-year period. This amounted to about a 3.9 percentage increase per year—slightly less than the rate of productivity growth for non-salaried staff.

The increase in output per non-salaried worker over the eleven-year period of about 45 per cent has not been as great as the increase in output per man-hour because there has been a decline in the number of standard hours per week. In 1954, standard hours per week in the four provinces varied between 48 and 60, while in 1964 they varied between 44 and 54.

Trends in Hourly Wage Rates

Figure 9 illustrates the hourly wage rates of pulpwood cutters and mechanics in Newfoundland, New Brunswick, Quebec, Ontario and Eastern Canada from 1957 to 1965.[14] Pulpwood cutters and mechanics represent about 55 per cent of total non-office employees in Eastern Canada. It

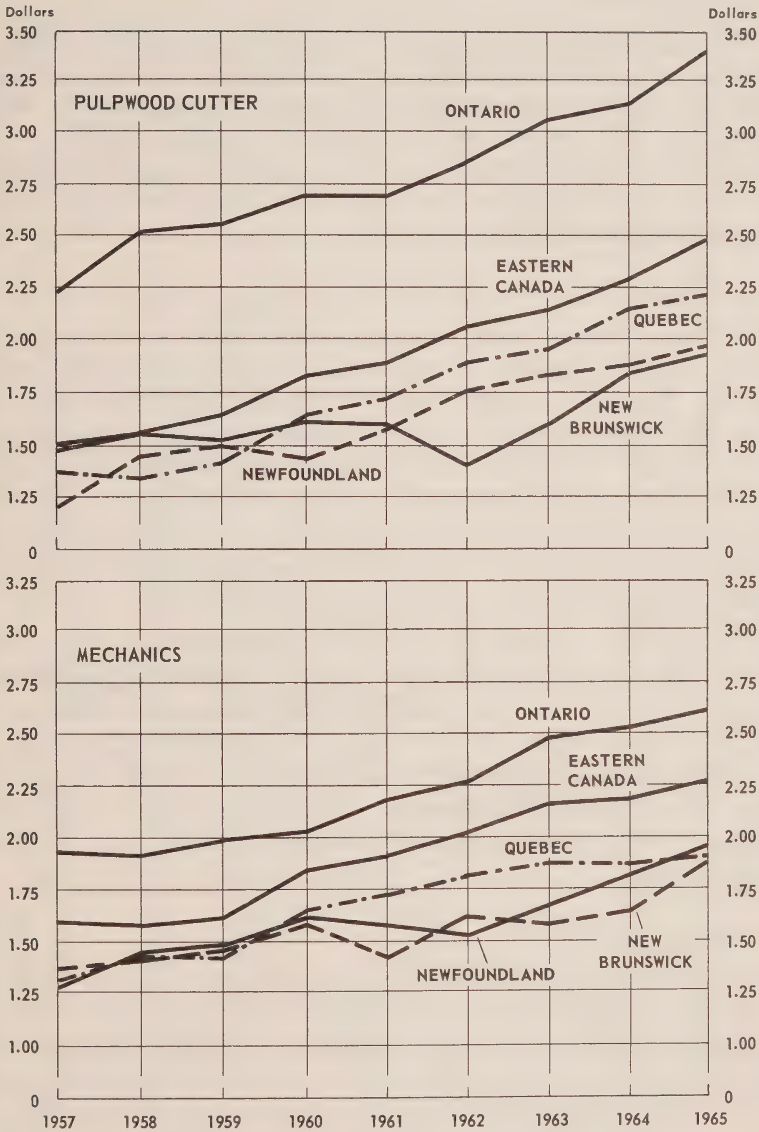
Figure 8



Source: See note 1, p.

Figure 9

HOURLY WAGE OF PULPWOOD CUTTERS AND MECHANICS IN EASTERN CANADA, ONTARIO, QUEBEC, NEW BRUNSWICK AND NEWFOUNDLAND 1957–1965



Source: Canada Department of Labour, WAGE RATES, SALARIES, AND HOURS OF LABOUR, *1957–1965.*

is immediately apparent that Ontario wage rates for these two occupations far exceeded the wage rates for Quebec, and that, in recent years, the wage rates in Quebec have been somewhat higher than those in Newfoundland and New Brunswick.

The wage rates shown for pulpwood cutters and mechanics are higher than those for most other occupations in the industry. Also, the mechanics' rate in the pulpwood logging industry in Eastern Canada, generally speaking, is higher than the rate of auto repair and garage mechanics in the same provinces. Presumably, this reflects a need to pay above-average rates for comparable labour in order to induce workers to enter and remain in the relatively isolated logging camps.

Trends in Labour Cost per Cunit

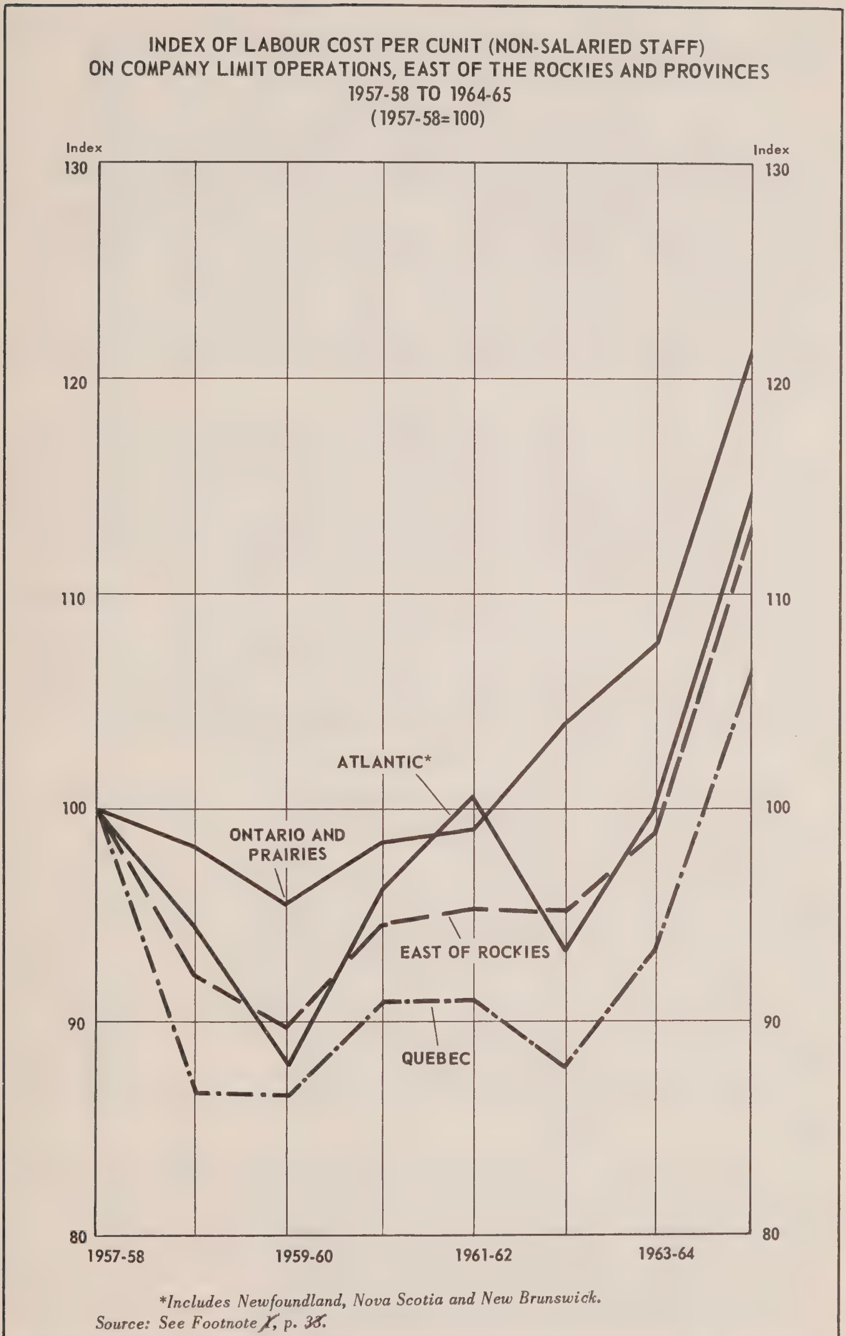
As Figure 10 shows, trends in labour cost per cunit have been broadly similar in Quebec, Ontario, and the Atlantic region.[15] In all three areas, costs have fluctuated noticeably from 1957-58 to 1962-63 with sharp increases in 1963-64 and 1964-65. In the earlier years the costs were generally lower than the 1957-58 level. This may be explained by the rapid rise in labour productivity between 1956-57 and 1962-63 which has served to offset the wage rate increases for the same period. The sharp increases in labour cost per cunit since 1962-63 may be attributed to the decline in man-hour production and the concomitant increases in wage rates.

Although it is possible to calculate the relative labour costs in the different regions this has not been done here. The existence of two potential productivity figures creates two potential labour cost per cunit relatives between provinces. However, it would appear, by either measure, that costs in the Atlantic region are somewhat lower than those in Ontario and costs in Quebec are somewhat higher. But these cost per cunit relatives apply only to non-salaried personnel. Provincial data for total labour costs per cunit are not available.

Occupational Changes

A detailed examination of occupational changes is given in Tables 3 to 6 inclusive. Percentage distributions of occupations in the pulpwood logging industry in Eastern Canada, Ontario, Quebec, New Brunswick and Newfoundland have been calculated from a compilation of the completed returns to the Department of Labour's annual survey of Wage Rates, Salaries and Hours of Labour. A brief description of the survey and a tabular presentation of the compiled occupational statistics are given in Appendix A. The major qualifications and description necessary to inter-

Figure 10



*Includes Newfoundland, Nova Scotia and New Brunswick.

Source: See Footnote ~~1~~, p. ~~38~~.

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pret the occupational statistics are discussed here while a more thorough examination is presented in the Appendix.

The total includes all non-office employees on the payroll on the pay day of one pay period in each year reported by the firms. The pay period was almost always in the peak logging activity months—September to November. The specified production, maintenance and service personnel occupations cover those occupations asked for and coded in the survey. The unspecified occupations category is residual. It consists of the total non-office employees minus the sum of the specified occupations shown in the tables. Some of the occupations represented in this category are footnoted in each of the tables, but the occupations of a majority of this group are unknown.

There have been some changes in the reporting methods and coverage of the survey during the period, and the series is therefore not as consistent as might be desired. However, it is the only source of such information and thus provides the best available data. The largest change of this nature took place in 1960 when the type of form used in the survey was altered. The introduction of the new form apparently affected the occupational distribution in Table 3 (as well as Tables 4 to 6 inclusive). Pulpwood cutters in Table 3 declined from 63.3 per cent of the total non-office employees in 1959 to 52.0 per cent in 1960, and the unspecified occupations category increased from 10.7 of the total non-office employees to 21.4 per cent. The other occupations remained relatively stable.[16]

Notwithstanding these obvious limitations of the occupational structure statistics, some useful trends can be discerned from them.

In Eastern Canada, tractor drivers (which include a large number of skidder operators) increased from 1.6 per cent of total non-office employees in 1956 to 5.1 per cent in 1965. During the same period, teamsters declined from 7.1 per cent of total non-office employees to 1.8 per cent. These changes were undoubtedly caused by the increased substitution of machinery for horses in transporting the pulpwood from the stump area to the landing. Truck drivers and scalers rose over the ten-year period, roadmen and swampers declined considerably, and loaders remained relatively stable.

The maintenance and service personnel percentage figures for Eastern Canada declined slightly from 1956 to 1965. The figures from 1956 to 1959, however, are not directly comparable to those of 1960 to 1965 because non-production labourers have been included in the maintenance and service personnel figures since 1960. This means that if the non-production labourers were excluded from the table, the maintenance and service per-

Table 3. Percentage Distribution of Occupations in the Pulpwood Logging Industry in Eastern Canada, 1956-1965

Occupation	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Total non-office employees	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Production workers	75.6	75.9	77.1	80.9	68.7	68.9	68.5	69.9	72.1	71.3
Pulpwood cutter	56.7	54.7	59.7	63.3	52.0	55.3	53.6	54.0	54.0	53.6
Truck driver	2.8	3.9	2.9	3.0	3.7	1.6	2.5	3.6	4.6	4.3
Log truck driver	2.8	3.9	2.9	3.0	3.4	–	1.9	2.9	3.8	3.1
Heavy truck driver	–	–	–	–	0.2	1.4	0.3	0.5	0.6	1.1
Light truck driver	–	–	–	–	0.1	0.2	0.3	0.2	0.2	0.1
Tractor driver	1.6	2.2	2.0	2.2	2.0	2.8	3.8	4.2	4.7	5.1
Teamster	7.1	6.7	6.6	6.0	5.9	2.9	2.3	1.7	2.2	1.8
Scaler	0.6	0.9	0.7	0.5	0.8	1.1	1.5	1.7	1.8	1.9
Loader	1.7	2.4	1.8	1.5	1.7	1.7	1.8	1.6	1.7	1.4
Roadman and swamper	5.0	5.1	3.4	4.4	2.6	2.3	2.1	2.2	2.1	2.2
Labourer	–	–	–	–	–	1.2	0.9	0.9	1.0	1.0
Maintenance and service personnel	9.8	9.5	8.0	8.4	10.1	9.1	9.8	8.4	9.6	9.2
Cook, cookee and choreboy	6.3	6.0	4.9	4.8	4.0	4.3	4.1	4.2	4.4	4.2
Mechanic	0.9	1.0	0.9	1.1	0.8	0.9	1.0	1.1	1.4	1.5
Labourer	–	–	–	–	3.3	2.1	2.7	1.6	2.3	2.1
Other maintenance and service personnel	2.6	2.5	2.2	2.5	2.0	1.8	2.0	1.5	1.5	1.4
Unspecified occupations	14.6	14.6	14.9	10.7	21.4	22.0	21.7	21.7	18.3	19.5

SOURCE: Table A-1.

sonnel percentage figure would read 7.1 per cent in 1965 instead of 9.2 per cent. If the 1956 figure of 9.8 per cent were compared to the 7.1 figure of 1965, a sizable decline would appear in this group of occupations. "Cook, cookee and choreboy" and "other maintenance and service personnel" actually declined from an aggregate of 8.9 per cent in 1956 to 5.6 per cent in 1965. With the sharp rise in the use of machinery, one would expect a corresponding increase in the percentage of mechanics; but surprisingly, mechanics rose only from 0.9 per cent of the total non-office employees in 1956 to 1.5 per cent in 1965. It is possible that their rise may have been slowed by a reduction in necessary repairs caused by improved machinery, better adapted to the needs and working conditions of the industry.

In Ontario (Table 4), while tractor drivers (including a large number of skidder operators) increased from 2.9 per cent in 1956 to 5.8 per cent in 1965, teamsters diminished from 0.5 per cent to nil. Truck drivers and scalers exhibited sizable percentage increases from 1956 to 1964 while loaders decreased slightly and roadmen and swampers and production labourers dropped strikingly.

The maintenance and service personnel declined from 1956 to 1965 in Ontario despite the inclusion of non-production labourers in the 1960-65 period. There was a sharp decline in the "cook, cookee and choreboy" category over the ten-year period, dropping from 8.0 per cent to 2.9 per cent. This may be attributed in large part to the increase in commuter operations[17] and adoption of cafeteria services in many camps. Over the same years a slight decline was recorded in the "other maintenance and service personnel" group of occupations while mechanics rose from 1.3 per cent to 3.6 per cent.

In Quebec (Table 5), tractor drivers rose swiftly from 1.4 per cent in 1956 to 5.8 per cent in 1965 while teamsters dropped drastically from 9.6 to 2.1 per cent. Truck drivers and scalers increased noticeably whereas loaders and roadmen and swampers dropped by about half over the ten years.

The Quebec maintenance and service personnel figure declined noticeably over the ten-year period when non-production labourers were excluded. There were also noticeable decreases in the "cook, cookee and choreboy" and "other maintenance and service personnel" occupational groups. Mechanics were comparatively constant.

The trends for tractor drivers and teamsters in Newfoundland and New Brunswick (Table 6) are less strong than those in Quebec. Tractor drivers increased from 1.0 to 3.2 per cent from 1956 to 1965 whereas

Table 4. Percentage Distribution of Occupations in the Pulpwood Logging Industry in the Province of Ontario, 1956-1965

Occupation	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Total non-office employees	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Production workers	71.0	61.4	69.5	78.4	68.9	66.6	69.8	68.3	62.6	67.2
Pulpwood cutter	61.5	44.6	52.5	66.6	58.2	54.7	56.9	54.7	51.2	53.7
Truck driver	3.8	6.2	3.2	5.2	4.0	3.2	4.4	4.8	4.5	4.6
Log-truck driver	3.8	6.2	3.2	5.2	3.3	–	3.5	3.9	3.7	3.5
Heavy truck driver	–	–	–	–	0.4	3.1	0.5	0.5	0.6	1.0
Light truck driver	–	–	–	–	0.3	0.1	0.4	0.4	0.2	0.1
Tractor driver	2.9	5.0	3.3	4.2	3.5	3.7	4.6	5.4	4.8	5.8
Teamster	0.5	1.1	7.3	0.1	1.1	*	*	*	*	–
Scaler	0.9	1.6	1.2	1.1	1.1	1.2	1.3	1.3	1.3	1.6
Loader	0.8	2.0	0.9	0.9	0.9	0.4	0.4	0.5	0.1	0.7
Roadman and swamper	0.6	0.9	1.1	0.3	0.1	0.2	0.1	0.4	*	–
Labourer	–	–	–	–	–	3.2	2.1	1.2	0.6	0.8
Maintenance and service personnel	11.6	14.4	8.0	8.2	10.8	8.9	8.7	8.6	9.8	9.5
Cook, cookee and choreboy	8.0	8.8	4.4	4.3	3.6	3.5	3.5	3.1	3.0	2.9
Mechanic	1.3	2.9	1.7	2.3	2.4	2.2	2.4	2.7	3.6	3.7
Labourer	–	–	–	–	3.0	1.4	1.0	1.2	1.8	1.2
Other maintenance and service personnel	2.3	2.7	1.9	1.6	1.8	1.8	1.8	1.7	1.4	1.7
Unspecified occupations	17.4	24.2	22.5	13.4	20.2	24.5	21.5	23.0	27.6	23.3

*Less than 0.05 per cent.
SOURCE: Table A-4.

Table 5. Percentage Distribution of Occupations in the Pulpwood Logging Industry in the Province of Quebec, 1956-1965

Occupation	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Total non-office employees	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Production workers	75.9	79.9	80.4	82.7	71.0	68.9	68.3	68.0	76.5	73.3
Pulpwood cutter	53.5	56.4	63.2	62.5	50.2	54.9	52.8	50.0	56.1	53.9
Truck driver	2.1	2.8	2.3	2.6	3.3	1.1	1.6	3.1	3.7	3.3
Log-truck driver	2.1	2.8	2.3	2.6	3.0	–	1.0	2.5	3.1	2.7
Heavy truck driver	–	–	–	–	0.2	0.9	0.3	0.4	0.5	0.5
Light truck driver	–	–	–	–	0.1	0.2	0.3	0.2	0.1	0.1
Tractor driver	1.4	1.7	1.8	2.2	1.8	2.8	3.7	4.4	5.1	5.8
Teamster	9.6	8.7	6.6	6.6	8.9	3.6	3.2	2.7	2.7	2.1
Scaler	0.6	0.9	0.5	0.5	0.9	1.2	1.5	1.8	2.0	2.1
Loader	1.7	2.6	1.8	1.7	2.1	1.2	1.5	1.4	1.6	0.8
Roadman and swamper	7.0	6.8	4.2	6.6	3.8	3.2	3.3	3.5	3.6	3.7
Labourer	–	–	–	–	–	0.9	0.7	1.1	1.6	1.6
Maintenance and service personnel	9.6	8.8	7.9	8.6	11.1	8.4	9.9	8.1	10.2	9.2
Cook, cookee and choreboy	6.1	5.7	4.8	4.9	4.3	4.5	4.6	4.7	5.2	4.9
Mechanic	0.8	0.8	0.8	1.0	0.6	0.7	0.8	0.8	0.8	1.0
Labourer	–	–	–	–	4.0	1.5	2.1	0.8	2.3	1.8
Other maintenance and service personnel	2.7	2.3	2.3	2.7	2.2	1.7	2.4	1.8	1.9	1.5
Unspecified occupations	14.5	11.3	11.7	8.7	17.9	22.6	21.8	23.9	13.4	17.5

Source: Table A-3.

Table 6. Percentage Distribution of Occupations in the Pulpwood Logging Industry in the Atlantic Provinces, 1956-1965

Occupation	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Total non-office employees	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Production workers	80.6	74.8	70.6	77.6	62.0	70.7	67.8	75.8	71.0	70.7
Pulpwood cutter	63.8	58.0	51.2	62.9	51.8	57.0	52.0	62.6	51.9	52.8
Truck driver	4.4	5.7	5.6	2.6	4.6	1.5	3.2	3.7	6.4	5.9
Log-truck driver	4.4	5.7	5.6	2.6	4.6	–	2.9	2.8	5.3	3.6
Heavy truck driver	–	–	–	–		1.3	0.1	0.7	0.7	2.1
Light truck driver	–	–	–	–		0.2	0.2	0.2	0.4	0.2
Tractor driver	1.0	1.0	1.5	0.9	1.3	1.8	3.3	2.9	3.6	3.2
Teamster	5.2	4.4	5.9	8.8	1.7	3.4	2.3	0.8	3.1	2.6
Scaler	0.4	0.4	0.8	0.3	0.2	0.8	1.6	1.8	1.8	1.7
Loader	3.0	2.3	3.2	1.2	1.1	4.0	4.2	3.3	3.3	3.4
Roadman and swamper	2.8	3.0	2.4	0.9	1.3	2.1	1.2	0.6	0.9	1.1
Labourer	–	–	–	–	–	0.1	*	0.1	*	–
Maintenance and service personnel	8.2	7.6	8.4	7.3	6.9	11.1	10.9	9.0	8.2	8.8
Cook, cookee and choreboy	5.4	4.4	5.3	4.7	3.6	4.6	3.4	3.9	4.2	3.9
Mechanic	0.5	0.2	0.5	0.3	0.3	0.5	0.4	0.4	0.5	0.9
Labourer	–	–	–	–	1.4	4.3	6.0	4.0	2.7	3.3
Other maintenance and service personnel	2.3	3.0	2.6	2.3	1.6	1.7	1.1	0.7	0.8	0.7
Unspecified occupations	11.2	17.6	21.0	15.1	31.1	18.2	21.3	15.1	20.8	20.5

*Less than 0.05 per cent.
SOURCE: Table A-2.

teamsters fell from 5.2 to 2.6 per cent. Truck drivers, scalers and loaders increased whereas roadmen and swampers dropped from 2.8 to 0.9 per cent over the ten years.

The maintenance and service personnel percentage figures show a decline when non-production labourers are removed as "cooks, cookees, choreboys" and "other maintenance and service personnel" diminish. Mechanics rose from 0.5 to 0.9 per cent over the period.

Changes in Seasonality

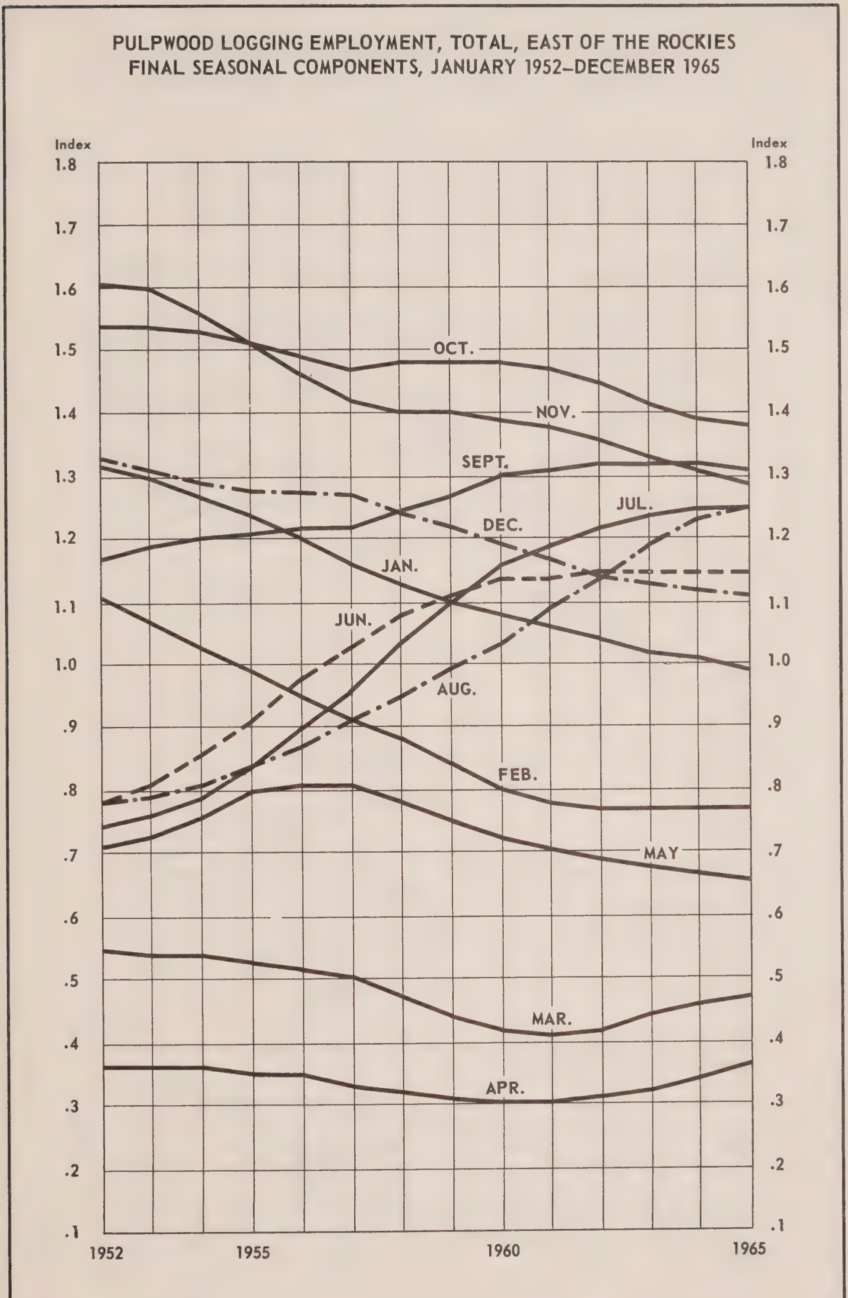
The impact of mechanical and other innovations on productivity, labour costs and the occupational structure is fairly clear and direct. With regard to seasonality, however, the chain of causality is much less evident. An increase in overhead costs caused by the introduction of machinery should tend to exert pressure for a decrease in seasonality. This, however, has by no means been the only influence at work. Changes in transportation systems and work methods have also probably played an important role and it is possible that a major share of the credit lies in changes in the nature of the labour supply. The gradual freeing of logging from dependence on agriculture for its labour supply has probably tended to reduce seasonality to some degree.

Figures 11 to 14 inclusive show the seasonal components for each of the twelve months from 1952 to 1965 for total employment in the area east of the Rockies and for non-staff employment in Ontario, Quebec, and the Atlantic area. The sum of the seasonal components in any one year is 12, and the average therefore is 1.0. Thus a month with a component of 1.6 is a month which tends to have employment 60 per cent higher than average. A decline in the seasonal component for a month shows that there is a tendency for a smaller share of the year's employment to occur in that month.[18]

In broad terms, it can be seen that seasonality of employment is highest in Quebec, somewhat lower in the Atlantic area, and (by comparison) quite low in Ontario. The high months for total employment east of the Rockies currently fall in the August to November period and this is true in each of the other regions as well—except that June edges out August in the Atlantic area. The low months everywhere are March, April, and May.

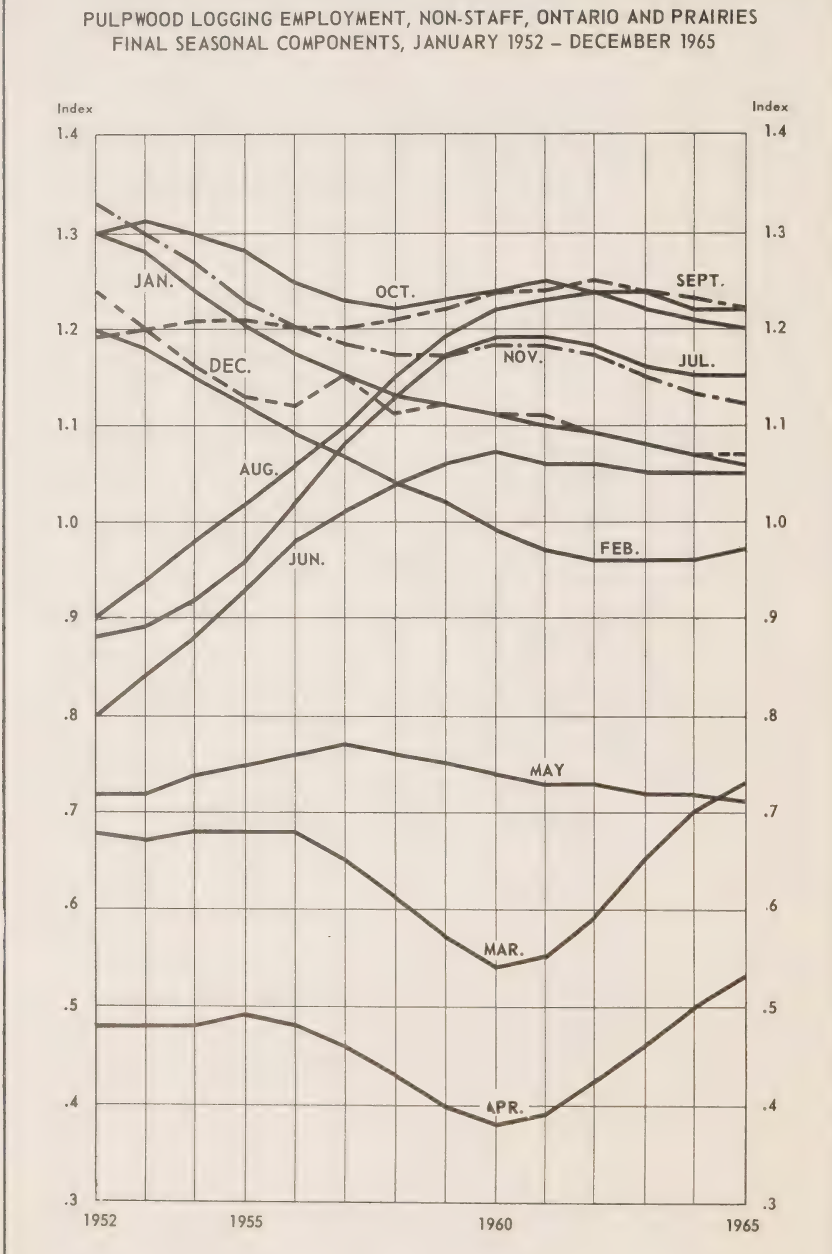
In many respects, this pattern of seasonality is quite different from that which prevailed in 1952. In general, east of the Rockies more work has shifted to the summer months—July, August, and to a lesser extent, September. November, October, and particularly January and February,

Figure 11



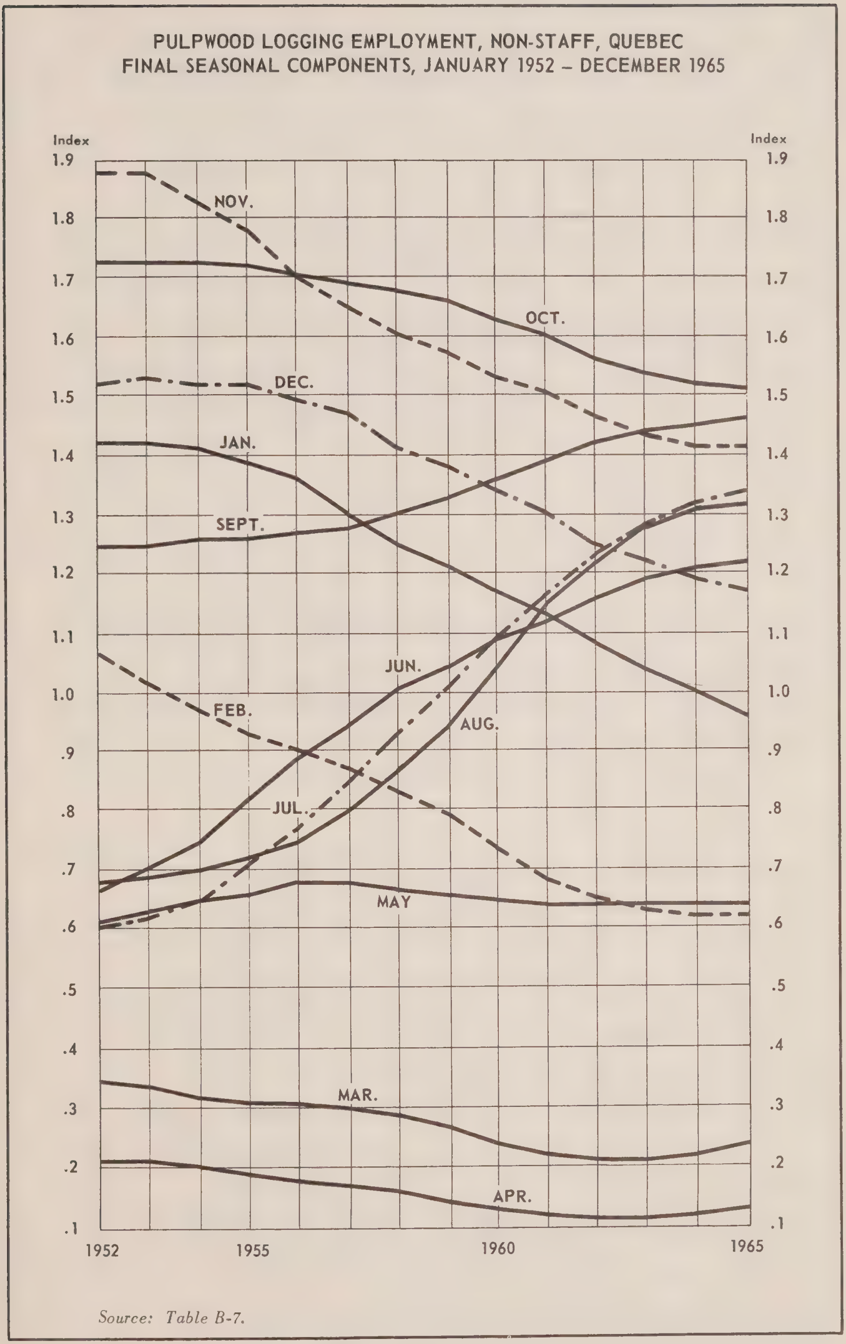
Source: Table B-5.

Figure 12



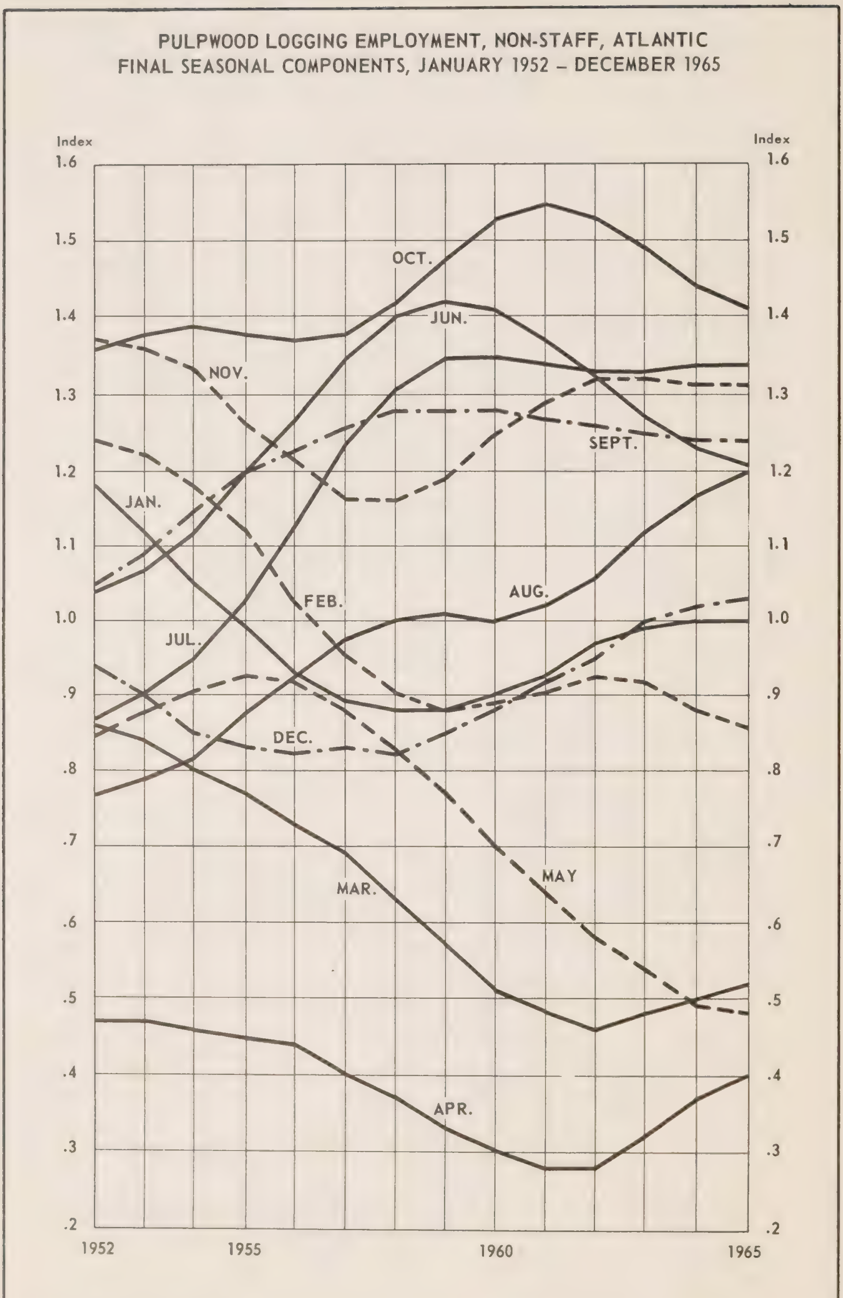
Source: Table B–6

Figure 13



Source: Table B-7.

Figure 14



Source: Table B-8.

have tended to be lighter work months than in the past. These general trends are the result of the occasionally somewhat opposed trends observable in the individual regions. Much of the change appears to have taken place prior to 1957 or 1958 and the components have been significantly more stable since then.

In order to summarize these trends, an index of the trend toward or away from a nine-month employment year has been constructed.[19] This index essentially measures the lack of seasonality *within* the nine months which have the highest seasonal components. Thus, if employment tended to be equal in each of the nine high months the index would reach zero, showing that a nine-month year had been reached regardless of movement in the remaining three months. Figure 15 shows a very marked trend toward a nine-month year until about 1958 in all areas except the Atlantic, but very little change since then. As the earlier graphs suggest, Ontario is closest to a nine-month year and Quebec furthest away. The Atlantic region, where the components depend on relatively small numbers of workers, shows wide and inexplicable fluctuations in its nine-month index.

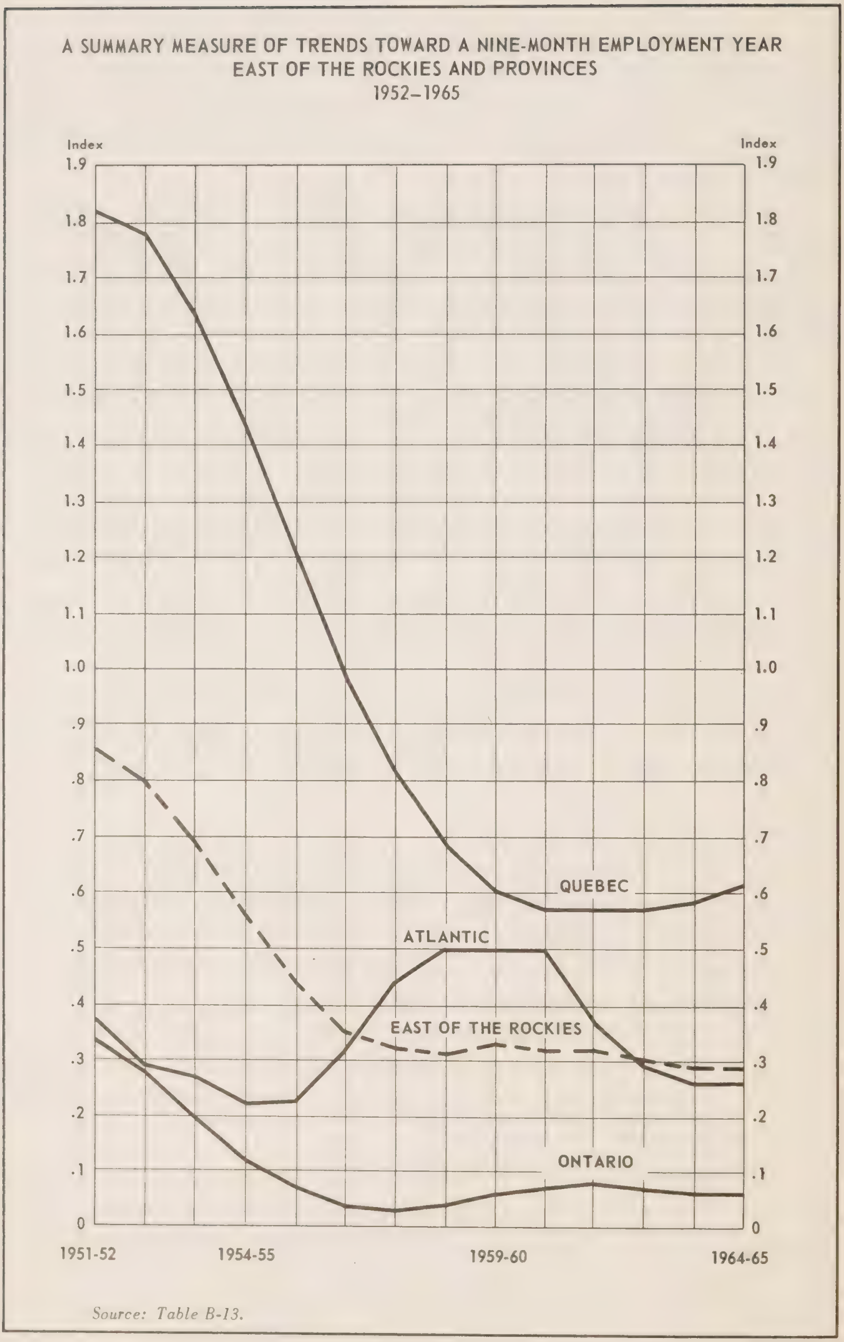
Despite these changes, employment seasonality in pulpwood logging east of the Rockies remains somewhat greater than in the Canadian forest industries generally. In 1964, the amplitude of the seasonal components in the industry was about one-third greater than in Canada forestry. Employment seasonality in both industries is much greater than seasonality in manufacturing and the very stable service industries.

Labour Turnover[20]

One of the outstanding characteristics of the Canadian forestry industry is the exceptionally high level of turnover of its labour force. Dominion Bureau of Statistics data show that, for every 100 persons on forestry payrolls in Eastern Canada during an average year, about 400 are hired in that year. The separation rate for the industry is typically about double the separation rate in construction, the next highest industry. In 1963-64, about 7.1 per cent of all workers on forestry payrolls left each week, as compared to figures of 3.8 per cent in construction and 1.4 per cent for all the industries covered.[21]

The high turnover rates in forestry are caused largely by two factors: high seasonality and a labour force with a high level of inter-firm and inter-industry mobility. It is frequently suggested that both of these factors have been changing in a manner which would tend to reduce turnover rates in the industry. A widespread trend toward the "professional logger" has been observed for many years. To the extent that forestry workers are coming

Figure 15



Source: Table B-13.

to regard woods work as a vocation, rather than a winter occupation to be combined with other work in other seasons of the year, they may be disposed to remain in one camp for longer periods of time. Changes in the nature and attitudes of woods workers are, however, almost impossible to measure directly. In recent years some pulpwood operations have switched over from a camp to a commuter-type operation. This should tend to promote more stability among the labour force involved.[22] Stability is also being fostered, especially in Quebec, by the increasing role of seniority in labour contracts.[23]

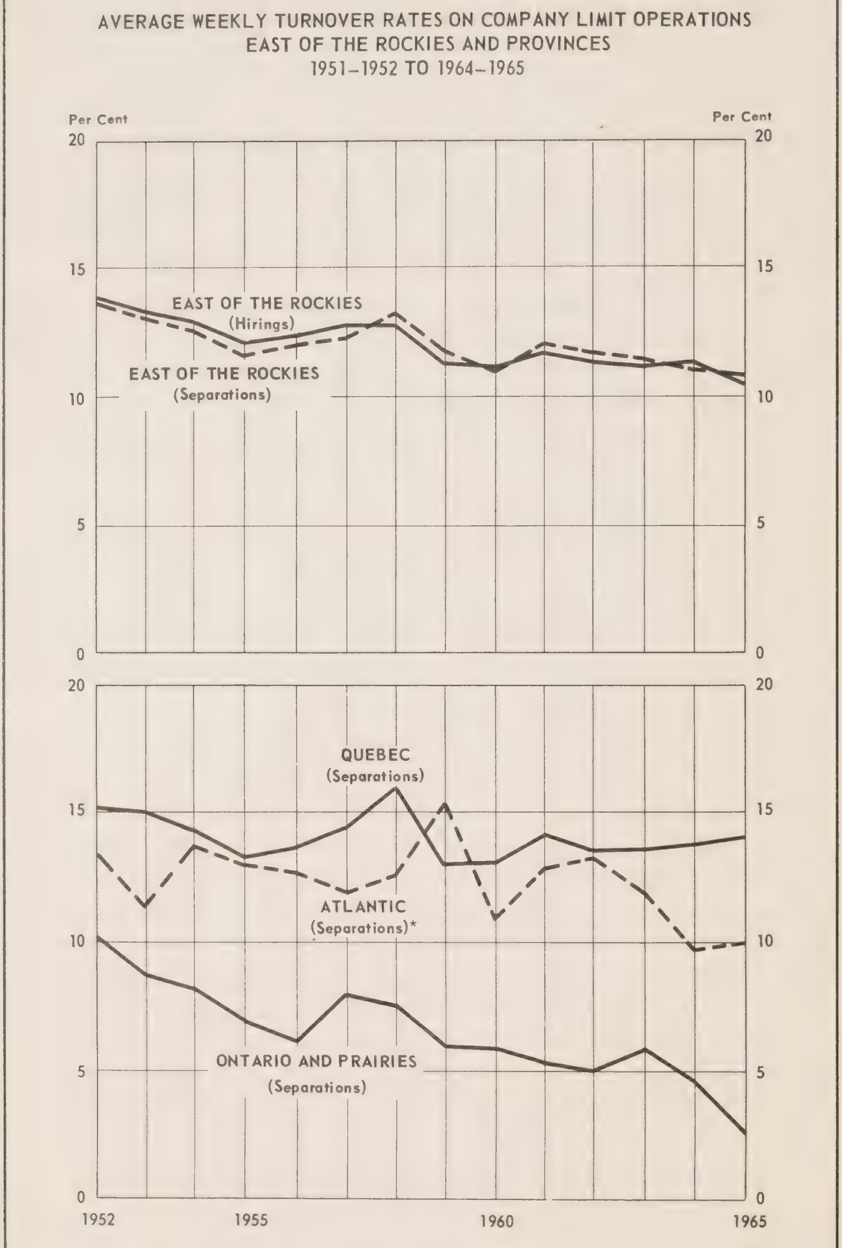
The currently available data on seasonality seem to show a definite decline in Ontario and Quebec and, other things being equal, we would expect turnover to have declined more rapidly in those provinces than elsewhere. Figure 16 shows the separation rates for the different areas of east of the Rockies for the period from 1951-52 to 1964-65. These data, which are based on company limit employment and separations,[24] show turnover declining in all provinces.

The average weekly separation rate for Ontario operations has shown the sharpest and most consistent decline during the period, despite the fact that it was considerably lower than the rates in other areas at the beginning of the period. The separation rates in Quebec and the Atlantic region have been well above 10 per cent per week through nearly all of the period, with the Atlantic showing a faster decline than Quebec.

It would appear that much of the turnover is associated with seasonality. Data on "quits to be replaced" (see Appendix, Table C-3) show much lower levels than the gross separations data.[25] In areas east of the Rockies they have shown a gradual downward trend since 1951 but even in the 1963-64 wood year they amounted to 2.6 per cent of the work force each week.[26] It should be noted that this largely voluntary rate is considerably above the 1.4 per cent per week total separation rate for all industries in the same period. The ratio of "quits to be replaced" to total separations displays considerable variability both between regions and over time, as a comparison of Tables C-2 and C-3 will show. In the earlier years of the period, "quits to be replaced" east of the Rockies generally accounted for 30 per cent to 50 per cent of all separations but since 1959 have accounted for about 20 per cent to 30 per cent of the declining separation rate.

It must be pointed out, however, that in some areas, such as Newfoundland or New Brunswick, weeks may go by without any reported "quits to be replaced". Whether this reflects under-reporting of the number of "quits to be replaced", unusually strong attachment to available employment, or a lack of necessity for replacing the quits is not known.

Figure 16



*Includes Newfoundland, Nova Scotia and New Brunswick.
Source: Table C-2.

Sources of Purchased Pulpwood

Unfortunately, there is very little comprehensive data available concerning the conditions under which the purchased one-third of Eastern Canadian pulpwood is produced. Industry estimates suggest that one-third of the purchased wood is supplied by farmers and the remaining two-thirds is furnished by various other smaller operators and individuals cutting on Crown land. The main source of data concerning farm woodlots is the census. This provides information such as the amount of woodland, the volume of pulpwood and other wood cut on census farms. The definition of a farm in the 1961 census was, however, somewhat restricted—much more so than in previous censuses—and thus no comparison over time is possible.[27]

Census farms produced only about 6 per cent of the total pulpwood cut in Eastern Canada in the 1960-61 wood year.[28] Newfoundland census farms accounted for only 0.2 per cent of that province's pulpwood production and Ontario farms 3.7 per cent of provincial output. Quebec and New Brunswick census farms were more important in their provinces, accounting for 7.1 per cent and 8.8 per cent respectively of the provincial output.

Census farms are only a minor source of pulpwood, and pulpwood is, in turn, only a minor source of income for most census farms. Only 34,651 of a total of 230,648 Eastern Canadian census farms reported sales of pulpwood in the twelve months preceding the census. These 34,651 farms sold an average of 18 cunits of pulpwood each. The value of all forest products sold averaged about $600 per farm reporting sales, and amounted to about 2 per cent of all agricultural income in Eastern Canada. On some census farms, of course, pulpwood accounts for a major share of the income. In 1961, 1,688 of the 158,414 commercial farms in Eastern Canada derived more than half their income from the sale of forest products.[29]

The remainder of the roughly one-third of all wood which is purchased comes from non-census farms, tracts too extensive to be classified as farm woodlots,[30] and some Crown land cutting by small enterprises or individuals. Data from earlier periods suggest that most of this wood comes from small holdings. The 1951 census, which utilized a broader definition of a farm, showed total Canadian census farm pulpwood production to amount to about one-tenth of total Canadian pulpwood production. By comparison, other D.B.S. data showed that purchases "from farmers and other small holdings" accounted for 24 per cent of all pulpwood used by Canadian mills in 1951.[31] It would appear that much of the purchased wood comes from relatively small holdings, but comprehensive data do not appear to be available.

Purchases of pulpwood are made in a variety of ways with considerable difference between regions and mills. Pulpwood procured from holders of extensive tracts is commonly purchased directly as may be wood from smaller holders located near the mill. The bulk of the smaller transactions are made through a system of brokers and dealers. The mill requiring wood will give a "contract" to a broker for procurement and the broker will then, in effect, subcontract his requirements to "dealers" who procure the wood directly from the owners of the woodlots. The brokers are actually more akin to contractors or buying agents than the name would indicate. They make the necessary arrangements with dealers—in some instances, country storekeepers—or, to a lesser degree, with the producers themselves. The contracts which they undertake to fill are apparently generally not enforced, however, in the event that they are unable to supply the stipulated quantity. The same is true of the contracts which the brokers negotiate with dealers.

One significant development has been the growth of co-operative logging camps in Quebec under the aegis of l'Union Catholique des Cultivateurs. One hundred co-operative forestry associations are now affiliated with the U.C.C. and the 64 camps which operated in the 1963-64 season produced about 120.000 cunits of wood. The majority of these camps would appear to be relatively small by comparison with those utilized by pulp and paper companies.[32]

There is no simple method of determining the short-run responsiveness of the supplies of wood from farmers to the prices offered.[33] Quite obviously, the willingness of farmers to produce wood during the winter will depend not only on the price offered by the companies for the wood but on the alternative employment opportunities available locally. The variations in the annual cut of wood from farm woodlots appear to be considerable,[34] but the degree of responsibility for changes in the prices offered is, in each instance, difficult to assess.

REFERENCE NOTES

1. There is considerable interprovincial variation in the percentage of pulpwood which is obtained from company limits. In Nova Scotia the limit proportion is so low (under one-third) that the province has been excluded from the definition of Eastern Canada used in this study. Total pulpwood production in Nova Scotia accounts for under 4 per cent of all output east of the Rockies.
2. The percentage depends upon tree size and branchiness. See Keen. R. E., *Weights and Centres of Gravity Involved in Handling Pulpwood Trees,* Pulp and Paper Research Institute of Canada. Montreal. November. 1963.
3. This is so because barking has been cheaper at the mill. However. the amount of barking being carried out in the woods is increasing.
4. The percentage varies with tree species and size.

5. Crown Zellerbach's Northwest Timber Department is currently experimenting with portable barker-chippers called "Utilizers" to meet the problem of utilizing small logs and trees in the forest which could not otherwise be taken economically to sawmills or chipping plants for processing. See Peterson, H. W., *Utilizer Operations,* W. S. Index No. 2391 (B-1), paper presented at the 48th annual meeting of the Woodlands Section, Canadian Pulp and Paper Association, Montreal, March, 1966.
6. A number of firms are investigating the possibility of transporting wood chips by pipeline but the process is, at best, some years from full realization.
7. Bennett, W. D., *Logging Atlas of Eastern Canada,* Pulp and Paper Research Institute of Canada, 1958.
8. It is conceivable that the industry could minimize wood harvesting costs by standardizing the system and hardware to be used even though this would not be the most suitable approach under all conditions.
9. In early 1966 there were 10 to 12 portable Nesco slashers in use in Eastern Canada and about 8 or 9 more were understood to be on order.
10. This is not to suggest that cafeteria service or tree-length methods are more efficient than the alternatives in all cases. The point is simply that the decision to change or not to change is increasingly made on the basis of careful measurement and consideration of alternatives.
11. Koroleff, A. M., *New Approach to Collective Working Evaluation of Machinery Aggregations,* Canadian Pulp and Paper Association, Woodlands Section, No. 2051, August, 1961.
12. There is a trend towards supplying the pulpwood cutters with power saws on tree-length operations where the method of payment is day wages and incentive bonuses.
13. The data used to calculate the index of production per man-hour in Figure 8 were derived by dividing estimated limit pulpwood production by estimated man-hours. The productivity levels derived are only approximate. The difficulties involved in matching the employment, production and hours data may produce productivity levels somewhat different from the true level. Nevertheless, the trends are reasonably reliable.

    Limit pulpwood production data were obtained from an unpublished series compiled each year by D.B.S. The number of man-hours was derived by multiplying man-weeks by hours per week. The man-week data were compiled from CPPA weekly labour supply reports requested from the same establishments included in the limit production estimates. The CPPA weekly survey questionnaire asks for the daily average number of wage workers on logging operations during the week. These weekly wage-worker figures were summed giving a total man-week figure for the year. Hours per week were obtained from the Department of Labour's annual survey of Wage Rates, Salaries and Hours of Labour. These weighted standard hours per week represent almost all establishments primarily engaged in cutting and transporting pulpwood and logs for lumber and other products. Over 80 per cent of the employees included in these establishments process and haul pulpwood.

    Productivity figures were also derived using the same sources for the production and hours per week data but utilizing employment figures compiled from returns to the monthly D.B.S. survey of Employment and Payrolls. The latter statistics, however, represent employees on the payroll for the pay period reported and would include substantially all employees hired or laid off during that pay period. Because of the exceptionally high amount of labour turnover in pulpwood logging, payroll-based employment figures considerably overstate labour input. CPPA man-week figures exclude turnover and, for Eastern Canada, the produc-

tivity figures (for all employees) computed from them are somewhat higher than the Employment and Payrolls derived figures.

Productivity data derived from Employment and Payrolls data and from the CPPA employment data show, as noted, minor differences in levels. The inter-provincial productivity ratios are similar except in the case of the Atlantic region.

14. Hourly wage rates, shown in Figure 9, were not directly available and were computed from information extracted from the Department of Labour's annual survey of Wage Rates, Salaries and Hours of Labour. The computation procedure for the provincial wage rates can be summed up succinctly in the following relationship:

$$W_h = \frac{W_d}{H_w/D_w} = \frac{W_d}{H_d}$$

where W_h represents the wage rate per hour,
W_d represents the wage rate per day,
H_w represents the standard hours worked per week,
D_w represents the number of days worked per week,
and H_d represents the number of hours per day.

The Eastern Canadian wage rates are weighted averages of the provincial rates.

15. Labour cost per cunit figures were derived by dividing the estimated average annual wage bill on limit operations by the estimated yearly limit pulpwood production. The average annual wage bill is the product of two factors — man-weeks and an average weekly wage rate. Man-weeks worked each year were compiled from CPPA weekly labour supply reports. The average weekly wage rate was calculated by multiplying a weighted daily wage rate by the number of days worked per week. Occupational daily wage rates available from the Department of Labour's annual survey of Wage Rates, Salaries and Hours of Labour, were used to obtain the average wage rate per day. Seventeen occupations were included in the wage rate calculation and these are: pulpwood cutter, truck driver (time work), truck driver (piece work), tractor operator, teamster (time work), teamster (piece work), scaler, loader (piece work), loader (time work), roadman and swamper, cook, cookee, choreboy, mechanic, blacksmith, carpenter and handyman.

16. See Appendix A for a detailed discussion of the nature of the changes and the resulting distribution. The only other significant inconsistency (also discussed in the Appendix) was a change in timing of the survey in 1960.

17. A commuter operation is one where the forest worker travels from his home each day to the logging camp and returns home each evening.

18. The reader is referred to Appendix B for a more technical treatment of the subject and a comparison of the seasonal components calculated from CPPA employment data and D.B.S. employment data. The material in this section is based on CPPA data.

19. See Appendix B for an explanation of the method of calculation of this index.

20. "Turnover" as generally used relates to both hirings and separations from individual firms. In order to avoid presenting two sets of figures, the discussion here is carried out solely in terms of separation rates. Both hiring and separation rates are presented in Appendix Tables C-1 and C-2. The difference in the two rates is not sufficient to affect the orders of magnitude described here. A "separation rate" is the number of workers who leave the payroll during a given period divided, in this instance, by the number on the payroll, expressed as a percentage or ratio.

21. There is some degree of overstatement in all measures of turnover in logging because (a) some workers "quit" on Friday and are rehired the following

Monday, and (b) some transfers from one camp to another camp run by the same company are reported as quits and hirings.

22. But see some of the apparent drawbacks of commuter operations in Newfoundland described in Peters, R. D., *The Social and Economic Effects of the Transition from a System of Woods Camps to a System of Commuting in the Newfoundland Pulpwood Industry*, Memorial University of Newfoundland (M.A. Thesis), 1965.
23. Seniority is frequently cited as a major factor behind the lower turnover rates in Ontario. Loggers who do not report for work after recall lose their seniority.
24. The turnover rates presented here were derived from the weekly labour statistics supplied by the Canadian Pulp and Paper Association. Since the denominator is the average number of workers on the job rather than the number on the payroll, these data are not comparable with those obtained from the D.B.S. material. For definitions, qualifications, and data, see Appendix C.
25. The "quits to be replaced" series includes an unknown, but probably small, percentage of persons fired for cause.
26. The quit rate tends to understate the actual voluntary quits because quits which need not be replaced are not included.
27. The change in definition resulted in the exclusion from coverage of 27,398 units which would have been classified as farms in Eastern Canada on the basis of the 1951 census definition.
28. That is, from June 1, 1960 to May 31, 1961.
29. All farms with a total value of agricultural products sold of more than $1,200 (except institutional farms) are classified as commercial farms.
30. The census excludes from its definition of farm woodlots "large timber tracts run as a business separately from the agricultural holdings and which were leased or under permit solely for the cutting of forest products".
31. The other 12 per cent of the 36 per cent which was purchased in that year consisted of "other purchases, including sawmill waste", Canadian Pulp and Paper Association, *Reference Tables*, 1953, p. 5, Table 7.
32. In 1963-64 membership totalled 3,450, or an average of 50 workers per camp. L'Union des Cultivateurs, *Rapport 1963-64*, pp. 86-87.
33. There is, of course, no unique uncompensated supply curve for any commodity except when all other factors are given. In this area the problem is more severe than usual because the "other factors" are subject to an unusually high degree of variability.
34. See, for instance. Restrictive Trade Practices Commission, *Report Concerning the Purchase of Pulpwood in Certain Districts in Eastern Canada*, Department of Justice, Ottawa, 1958, p. 208.

Chapter III

FULLY MECHANIZED METHODS OF PULPWOOD LOGGING

A variety of new and improved machines and methods have contributed to the increase in productivity in pulpwood logging since 1950. Despite the success of these innovations, there appear to be even greater opportunities for cost reduction—primarily in the reduction of the manual effort needed to process and transport the wood from the stump to the intermediate landing. Even though the power saw (Figure 17) has vastly increased productivity in the felling operation, pulpwood cutters still account for over half of all non-office employees in the industry. Although the rapidly growing use of skidders and forwarders to transport pulpwood is increasing output per man-hour, manual effort is still required to stack the pulpwood into piles or bunches, so that the transporting machinery can pick up a full load.

The industry has felt that even the newer logging methods, using skidders and forwarders, have not reduced costs per cunit sufficiently to keep the industry competitive and much thought has recently been devoted to the development of continuous flow logging methods. The major characteristic of continuous flow methods is that they eliminate intermediate storage and handling. One way to make the flow continuous is to develop individual machines which combine more than one operation—such as using a "feller-skidder" to combine the felling operation with the skidding operation. Alternatively, logging methods can be made more continuous if the output of one machine is directly fed into another with no provision for storage between the two.

Continuous operations have advantages in that inventory costs are reduced and that handling costs incurred in moving pulpwood in and out of storage are eliminated. Non-continuous logging methods are, however, superior in a number of respects. A breakdown in one of the operations does not shut down the entire process. In addition, it is not necessary to have the close matching of the capacities of machines performing different operations which is a necessary feature of continuous methods if idle capacity is to be avoided. Non-continuous methods also allow more time for pulpwood to season—a factor which reduces loss through sinkage when wood is transported by water.

FIGURE 17. POWER SAW

A trend toward more continuous logging methods has been observable in recent years and is exemplified by the present development of equipment for the fully mechanized short-wood, tree-length and full-tree logging methods.[1]

Short-Wood System—Fully Mechanized

The first attempt at full mechanization of the short-wood system in Canada came in 1961 when the Canadian International Paper Company (CIP) and the Abitibi Paper Company each purchased a Buschcombine for testing on their limits (Figure 18).

This machine constituted a major technological innovation which permitted full mechanization of all the operations from cutting the tree through to stacking bolts of wood at the landing. However, field trials with the machines showed higher costs per cunit than with conventional logging methods and Canadian experimentation with the machine was halted in favour of more promising areas of exploration.

Experimentation with the Buschcombine was continued in the Southern United States and there are now 35-40 such machines in various stages of use or testing in that area. The major experimenter and user to date has been the International Paper Company—the parent of the Canadian International Paper Company—which operated 17 Buschcombines on its southern limits during 1964.

The 9-ton vehicle, operated by one man, travels through the woods from tree to tree. A pair of hydraulic shears cuts the tree at its base and the machine then picks up the full tree and feeds it horizontally through a series of blades which cut off the limbs and sever the trunk into 63-inch lengths. As bolts are cut off, the machine accumulates them on its rear platform and can tie them in 1.1 cunit bundles. The bundles can be either dropped in the woods for pickup and transfer to the landing by a forwarder or taken there directly by the combine itself.

A report on the experience of the International Paper Company with Buschcombines during 1964 was published in the following year.[2] The machine was used to cut, delimb, slash, and place bundles of pulpwood on hauling units under a variety of environmental conditions. Output per machine hour ranged from 1.3 cunits to 1.8 cunits with an average of 1.4 cunits. The variation was accounted for by differences in environmental conditions, the use of Buschcombines in various stages of development, and varying degrees of experience on the part of the crews. With the machines operating on a one-shift basis, downtime for repairs averaged about 10 per cent of planned work time—presumably partly because some repairs were

FIGURE 18. BUSCHCOMBINE

made outside scheduled work time. Cost per cunit is apparently sufficiently low to make the system competitive with conventional harvesting methods in the Southern United States.

It should be noted that a short-wood processor is now being developed by the Koehring-Waterous Company Limited, Brantford, Ontario—the Koehring "processor" (Figure 19). The prototype of this machine which went into the field late in 1964 is now undergoing major redesign and a new model is expected to be ready for testing in the summer of 1966. The capital cost of the machine is expected to approximate $75,000. The original model had a tree-cutting boom with a 23-foot reach and did not have to position itself at each tree as is the case with the Buschcombine. The boom would reach out, cut off the tree at its base, and place the full tree in a vertical position with its butt in the center of the machine. The tree would then be automatically fed down through the machine being delimbed and chopped into 8-foot lengths. This vertical processing feature permitted free movement of the machine and the tree-felling boom while the other processing operations were carried out. The processor would accumulate a one-cunit load of wood and would drop it on the ground to be picked up by a forwarder (Figure 20).

Tree-Length System—Fully Mechanized

The central piece of equipment currently developed for the fully mechanized tree-length method is the Tree Harvester (Figure 21). The first experimental model was built in 1959 and by 1965 there were seven harvesters in operation in Eastern Canada.

The tree harvester limbs, tops, fells and bunches tree lengths at the stump. The harvester, which is operated by one man, processes trees up to about 65 feet in height.[3] The operator positions the 30-ton machine so that as many trees as possible can be reached from one place. He then moves the 15-foot main boom out until the 65-foot telescopic vertical mast is against the tree. The limbing arms grasp the tree and travel up the mast, shearing off the limbs until the tree diameter is only 3 inches. At this point a single blade cuts off the tree-top. The operator then lowers the limbing arms to within 15-20 feet of the stump in order to hold the tree upright while it is cut at the stump by the "butt-shear". The last operation is to swing, tilt, and drop the tree-lengths into small straight piles which can readily be skidded to the landing place. Once tree lengths have been bunched by a tree harvester, a conventional skidder (Figure 22) can choke the tree lengths and skid them to a landing. Another method is to use a conventional skidder with a single long choker (snare) set around an entire bunched pile

FIGURE 19. KOEHRING PROCESSOR

FIGURE 20. KOEHRING FORWARDER

FIGURE 21. BELOIT TREE HARVESTER

FIGURE 22. CONVENTIONAL SKIDDER

of trees. Some companies are seeking further increases in skidder productivity with the development of a grapple skidder (Figure 23) which will pick up the bunched tree lengths in one motion as contrasted with the conventional skidder where choking or cabling of individual tree lengths is necessary. Once at the landing, the tree lengths may be cut into bolts of desired length by a slasher[4] (Figure 24) or circular saw, or, if adequate transportation is available, the tree lengths may be taken directly to the mill. The bolts are then stacked and are ready for loading onto long-distance transporting media.

The piling of the tree-lengths by the harvester eliminates one time-consuming operation. The skidder does not have to move from tree stump to tree stump choking individual tree-lengths but, instead, can pick up an accumulated load in one stop.[5] The bunching, therefore, greatly reduces choking time and can allow the skidder to operate at full capacity. Because the harvester automatically carries out the time-consuming task of removing limbs from trees, its advantage over the more traditional methods increases in stands where trees are exceptionally limby.

Despite its very considerable advantages over the traditional methods under the terrain and stand conditions for which it has been designed, the tree harvester's range of operations is limited by some of its physical characteristics. The machine weighs 30 tons and, because of its high main boom and telescopic mast attachment, has a high centre of gravity. Its great weight restricts severely the range of soil conditions under which it can efficiently operate. Many areas of Eastern Canada have soils which are not sufficiently firm to support the machine adequately, and thus it appears that in many operations it will not be possible to use a tree harvester except in winter when the ground is frozen.

The machine's high centre of gravity impedes its operation on hilly slopes. It operates very well in forest areas with slopes from 0 to 15 per cent but its productivity declines with increasing slopes and it cannot operate on a gradient of over 20 per cent. The slope problem severely impedes the general use of the tree harvester in Quebec—an area where rough and angular terrain is very common.

It is notable that the first harvesters in operation have been on Ontario limits. This is not accidental. In general, Ontario offers better operating conditions for the harvester than do the other provinces and it is only natural that the firms most interested in the development should be the major potential users.

The first harvester was built by the Marathon Corporation of Canada in 1959. The initial results showed a need for considerable modification and

FIGURE 23. GRAPPLE SKIDDER

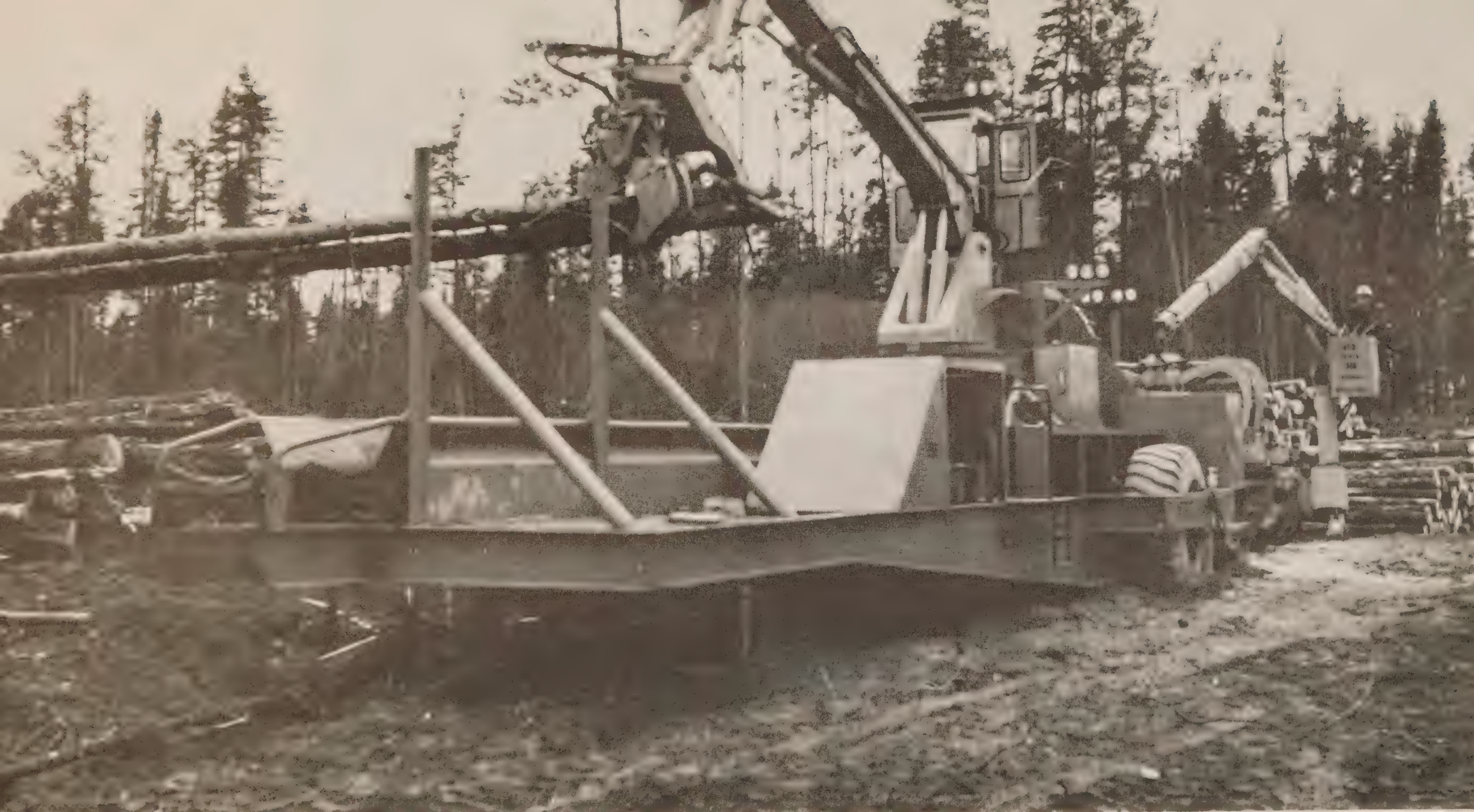


FIGURE 24. NESCO SLASHMOBILE

in 1960 the company built a more advanced prototype model called the Mark I. A further improved version, the Mark II, was constructed by Marathon in 1962. In the same year an equipment manufacturing firm, the Beloit Hibob Corporation of Ashland, Wisconsin, which had been attracted by the potential of the innovation, started to build harvesters on order. This company sold its first harvester to the Great Lakes Paper Company, of Fort William, Ontario. In 1963, a tree harvester was sold to the KVP Company Limited of Espanola, Ontario, and two harvesters were sold in 1964—one to Marathon and another to the Great Lakes Paper Company. In July of 1965, Domtar Limited, on the basis of a cost analysis conducted by Beloit on Domtar's limits in Ontario, purchased a Beloit tree harvester for testing. Kimberly-Clark also purchased a machine in 1965. In total, seven harvesters are being tested on five companies' limits in the Ontario woods today. In addition, one machine has been sold in Sweden, another went to the Southern United States, and one to Maine. At the close of 1965, orders were understood to have been received for one machine each from New Brunswick and Quebec. The machine's capital cost is about $85,000.

Full-Tree System—Fully Mechanized

As indicated earlier, the only full-tree harvesting methods in use in Eastern Canada are partially or fully mechanized experimental methods. In contrast to the tree-length, and particularly the short-wood system, the use of a full-tree system virtually necessitates mechanical hauling. In a full-tree system, the only processing carried out at the stump is the felling of the tree. The entire tree, including branches and top, is then transported to a landing where limbs and top are removed, the tree is cut into bolts and, possibly, the bark is removed.

Research into the possibilities of mechanical full-tree logging has led to the development of the Arbomatik processor (Figure 25), a machine which will limb, top, bark, and cut the wood into suitable lengths. A number of machines designed to perform the felling and skidding functions also have been under investigation, but to date most of the research effort has been concentrated on developing and refining the Arbomatik processor.

Since 1962, this research on full-tree harvesting machinery and methods has been carried on in Quebec by the Logging Research Associates (LRA). This is a joint venture on the part of three Canadian companies—the Canadian International Paper Company of Canada, Limited, the Quebec North Shore Paper Company (QNSPC)—an affiliate of the Ontario Paper Company, Limited—and Abitibi Paper Company Limited. Efforts to develop the equipment necessary for the use of a mechanized full-

FIGURE 25. ARBOMATIK PROCESSOR

tree method antedate the formation of the LRA. In 1958, the CIP began intensive development of an Arbomatik processor and in 1961 produced a prototype of the machine which is currently being developed and improved by the LRA. The QNSPC had experimented with all three logging systems and concluded that the full-tree system offered the greatest opportunities for cost reduction on its limits. The company experimented with two machines—the Vit-Feller-Buncher (VFB) and the Bombardier-Processing Unit (BPU). The VFB was a machine designed to approach each tree, fell it, collect the felled trees in a bunch, and skid them to the landing. The BPU was a machine similar in function to the Arbomatik processor—it operated at the landing where it limbed, barked, and slashed the logs and loaded the pulpwood, via a conveyor, on to pallets for trucking. Although the QNSPC stopped development on these machines when it joined in the formation of the LRA in 1962, it used the machines for a period.

The Arbomatik processor, which costs approximately $85,000 to purchase, is designed to operate at the landing place to which the full trees have been brought by skidders. The machine consists of a feeding mechanism, feed rolls, limber, barker and shearing device. The feeding mechanism consists of a 25-foot telescopic boom equipped with a tree grapple. The grapple picks up a tree, near its butt, and inserts the end in the feed rolls. Then the tree is released by the grapple and, while the tree is being limbed, barked, topped and bucked, the grapple picks up another tree. The processing is continuous.

The Arbomatik processor currently requires two men to operate it, as compared to one man for the tree harvester or Koehring processor. While one man is feeding the trees into the feed rolls of the Arbomatik, the other works at the rear of the machine arranging the bolts of pulpwood in straight piles. The Arbomatik processor functions at an intermediate landing whereas the Beloit harvester and Koehring processor operate in the stump area. Because of its semi-centralized location the Arbomatik's productivity is not directly affected by such factors as terrain and stand density which can considerably influence the productivity of the Beloit harvester or the Koehring processor. There is, however, a silvicultural consideration with the Arbomatik processor logging method. Since the full tree, including branches, is removed from the forest, there is a loss of the seeds and nutrient materials needed for regeneration and growth.[6]

The LRA is experimenting with two types of skidders for use in the fully mechanized full-tree method. One machine is the feller-skidder. This machine moves through the woods felling trees with a shearing device and loading the felled trees onto its back. Once it has accumulated a full load,

it skids the trees to a landing area where the Arbomatik processor processes them. The second type is the self-loading skidder. After the trees have been felled by pulpwood cutters with power saws, the self-loading skidder picks up the felled trees, loads them onto itself and, with a full load, proceeds to the landing area. A full load for both types of LRA skidders has been estimated to be one cunit.

Efficient use of the Arbomatik processor is not as strongly affected by terrain and stand conditions as is the use of the Beloit harvester. Since the machine remains at the intermediate landing, its own physical characteristics do not create any limitation, other than that of occasional movement from one landing to another. What limitations there are on the use of the Arbomatik processor derive from limitations on the mobility of the machines which bring the full trees to the landing. The types of articulated frame skidders currently in use are capable of operating under a wide variety of conditions. The degree to which machines still in the development stage, such as the feller-buncher or self-loading skidder, will be limited in their mobility remains to be seen. All factors considered, companies with extensive experience in the region suggest that the Arbomatik processor should be able to operate efficiently on between 70-90 per cent of the company limits in Quebec, an area where terrain severely limits the harvester.

It should be noted that the success of the Arbomatik processor full-tree logging method does not depend totally on the successful development of the feller-skidder and the self-loading skidder. The Arbomatik could carry on continuous processing with all of its input being furnished with the now conventional rubber-tired skidder.

A second full-tree logging method was introduced into the Eastern Canadian woods in the fall of 1965 when the Consolidated Paper Corporation began experimentation with the Sund Full Tree Processing System in Quebec.[7] This machine system was developed in Sweden over the last four years by Sunds Verkstader, a logging equipment development company. Ten systems are reported to be in operation in Europe at the moment, nine in Sweden and one in Italy.

The equipment in the Sund system operates at the intermediate landing (Figure 26). As used by Consolidated to date, trees are felled by pulpwood cutters and transported, with limbs still attached, to the landing by skidders. The machine system at the landing consists of three main parts—the feeder, the delimber, and the slasher. The mobile tree feeding unit picks up a full tree deposited at the landing by a skidder and carries it to the delimber. Once the feeder has placed the tree in the delimber it moves to pick up

FIGURE 26. SUND PROCESSING SYSTEM

another tree. At the same time the full tree is delimbed by the delimber and the tree length is moved by a conveyor to a slashing unit where it is cut into 8-foot lengths. The 8-foot bolts are then accumulated in a basket and removed from the slashing unit by a loader.

The main problem in this system has been to match the capacities of the three components. The most serious limitation in this regard has been the low slasher capacity. The slasher has reduced the production of the delimber to about 60 per cent of capacity. The delimber operator has been forced to pause while the tree lengths on the conveyor are being processed by the slasher unit. The productivity of the present slasher apparently cannot be increased much more. Another potential limitation has been the inability of the feeder fully to keep pace with the high capacity delimber. This has been attributed to the improper placing of trees at the landing by the skidder and to the feeding of too many trees into the delimber at the same time. It is evident that intelligent co-operation from the skidder operator and good judgment by the tree-feeder operator are necessary if the delimber is to function at capacity.

The company estimates that the cost per cunit of the Sund Processing System for all operations performed from the tree stump to the water landing will approximate the cost for a conventional method using wheeled skidders and performing the same operations.[8] The capital cost of the system operating at the landing area, excluding the loader, approximates $150,000. Production per man-hour in the Sund system is expected to be about 50 per cent greater than in the conventional system.

REFERENCE NOTES

1. In addition, experiments have been carried out aimed at making transportation methods more continuous. The Pulp and Paper Research Institute of Canada, in conjunction with pulp and paper companies and pipeline companies, began investigating the possibility of transporting wood chips by pipeline in the late 1950's. In 1964 a pilot study, involving 2,000 feet of pipeline of varying diameters, was initiated at Marathon, Ontario, in order to establish the feasibility of pipeline application. Press reports indicate that the experiments have been successful but that the pipeline may not be ready for commercial application for some years. Initially, the pipeline will likely operate between a final landing and the mill although there is a possibility that the pipeline may eventually move closer to the stump area.
2. "Cost/Production Report on the Buschcombine", *Pulpwood Production and Sawmill Logging*, Hatton, Brown and Company, Montgomery, Alabama, May, 1965, pp. 26-30.
3. Practically all trees suitable for pulpwood in allowable cut areas in Eastern Canada are under 70 feet in height.

4. A Nesco Slashmobile is gaining wider acceptance in the Eastern Canadian industry. There are currently about 10-12 on logging operations with another 8-9 on order.
5. For a discussion of the influence of tree size and stand density on the performance of the tree harvester and a self-choking skidder, see Dibblee, D. H. W., *The Effect of Some Stand Factors on the Performance of Mechanical Harvesting Equipment,* CPPA, Woodlands Section, Index 2348 (B-1), paper presented at the "Seminar on Forest and Mechanical Harvesting", Quebec City, August 31-September 2, 1965.
6. For a more detailed discussion of the silvicultural problem, see Silversides, C. R., *Developments in Logging Mechanization in Eastern Canada,* University of British Columbia, 1964, pp. 26-29; and G. F. Weetman, "The Need to Study Silvicultural Effects of Mechanized Logging Systems in Eastern Canada", *Forestry Chronicle,* 41(2), June, 1965 (252-6).
7. Lachance, Roger A., *Full Tree Logging and the Sund Tree Processing System,* CPPA, Woodlands Section, Index No. 2384 (B-1), paper presented at the 48th annual meeting of the Woodlands Section, CPPA, March, 1966.
8. This cost level is lower than the average achieved in Quebec during the testing period. Those responsible feel that, with more operator experience, and some simple improvements, this cost level should be readily attainable. An explicit assumption in the estimate is that the high-speed delimber will operate at only 60 per cent of its capacity because of the inherent limitations of the slasher used.

Chapter IV

THE ESTIMATES FOR 1970 AND 1975

Analytical Framework and Theoretical Considerations

The ultimate goal of this study is to estimate the direction, speed and magnitude of manpower dislocation and manpower shortages that would occur as a result of the prospective technological changes in the pulpwood logging industry in Eastern Canada. A basic step in the estimation of these manpower implications is to forecast the extent of diffusion of these multi-process machines into Eastern Canada's pulpwood logging industry. This section will develop the analytical framework that will form the implicit basis for the assessment of the extent of diffusion of innovations and for manpower estimates to be made later in this chapter.

In order to discuss the factors influencing use of new innovations it is necessary to define a number of terms. The "industrial extent (level) of diffusion", D_t, of an innovation will be understood to mean the percentage of the industry's output which is produced with the assistance of the innovation at time "t". The "rate of diffusion"[1] of an innovation within an industry refers to the speed at which the extent of diffusion is rising. Similar terminology will be used with respect to individual firms.

The industrial extent of diffusion of an innovation at any given time is a weighted average of the extent of diffusion of the innovation within the operations of the individual firms comprising the industry.[2]

It is neither necessary nor desirable to attempt to forecast diffusion rates on a firm level. The situation in this connection is rather analogous to forecasting the number of live births in any given year. Analysis of the factors influencing the live birth rate (e.g., the marriage rate, the unemployment rate, etc.) is a vital part of such a forecast. Through a study of the relationships it is possible to produce a tolerably correct short-run birth rate forecast. In order to achieve this goal, it is neither possible nor necessary to examine individual pregnancies.

It is only in recent years that econometric research has been undertaken on the factors determining the rate of diffusion of innovations within firms and industries. Because of its recent genesis, such research is limited in extent. Thus, the quantitative conclusions derived from it, although

plausible, must be applied with care and discretion. There are a host of factors potentially at play in a firm's decision as to whether and when to innovate and it is useful briefly to review them.[3]

For a number of reasons, a firm's size will affect its decision. Large firms, because they encompass a wider range of operating conditions, have a better chance of containing those conditions to which the innovation is initially applicable. When an innovation first appears, its application is often restricted to a fairly ideal set of operating conditions. Later, improvements are made that extend its usefulness and range of operation. Also, because large firms probably have more units of any particular type of equipment, they are more likely at any point in time to have some units in need of replacement. Thus, at any given point in time, the large firm is less likely to have to sell or scrap usable equipment in order to introduce the new machinery. The costs and risks involved in being among the first to use a new technique are likely to loom much larger for small firms than for big ones. Because of their larger financial resources, bigger engineering departments, better facilities for experimenting and closer ties with equipment manufacturers, bigger firms can play the role of the pioneer more cheaply and with less risk than can smaller ones.[4]

Research on the determinants of innovation in other industries in the United States suggests strongly that the probability that a firm will introduce a new technique is an increasing function of the proportion of firms already using it, and of the profitability of doing so, but a decreasing function of the size of the investment required.[5]

As the proportion of firms already using an innovation rises, more experience and information accumulate, thereby increasing the probability that a firm will introduce a new technique. Competitive pressures mount and "bandwagon" effects occur. Also, where the profitability of using an innovation is difficult to estimate, the mere fact that a large proportion of a company's competitors has introduced it may prompt a firm to consider it more favourably. The more profitable an innovation is relative to other innovations or conventional means of production, the greater is the chance that a firm will consider the profitability high enough to compensate for the risk involved and that it will seem worthwhile to introduce the new technique into a firm's operations. For equally profitable innovations, one would expect that a firm would be less likely to begin using those innovations which require relatively large investments. Firms are cautious about committing themselves to large investments and generally have difficulty in financing them. Edwin Mansfield examined twelve innovations in four industries in order to test the influence of a number of these variables.[6] An

analysis of the data for these innovations showed that the rate of imitation[7] tended to be faster for innovations that were more profitable and that required relatively small investments. Mansfield correlated the rate of imitation with the proportion of the total number of firms using an innovation for each of the twelve innovations. The correlation coefficients ranged from .46 to .96 with a median of .72.[8] These coefficients are indicative of a direct relationship between the probability that a firm will introduce a new technique and the number of firms already using it.

We have listed, then, four factors which appear strongly to influence a firm's decision whether or not to purchase a new technique: the size of the firm, the profitability of the investment, the amount of the investment necessary to purchase one unit of the innovation, and the number of firms already using the new machine. This list is by no means exhaustive. The durability of machinery currently used in the industry also influences to some extent the rates at which the new equipment will replace it. The greater the durability of the existing machinery the slower will be the replacement by the innovation. It seems likely that the rate of growth of a firm, its profitability, the age of the firm's president, its liquidity, and the profit trend of the firm may influence its choice whether or not to acquire a new machine. It should be noted, however, that Mansfield found no satistically significant relationship between these variables and the decision whether or not to purchase an innovation.[9]

Although these general factors of wide applicability help us in determining the likelihood of a firm purchasing a machine, they must be given specific content in order to determine the extent of diffusion of particular machinery into the pulpwood logging industry. The prospective innovations will encounter a unique set of factors. These factors affect the applicability of the tree harvester, the Arbomatik processor and other pieces of machinery and, consequently, must be included in an examination of machinery diffusion.

The first of these factors is the size of the tree, as measured in diameter at breast height (DBH). Tree size greatly affects the production per machine hour of the tree harvester and the Arbomatik processor. The greater the DBH, the higher will be the machine productivity; the smaller the DBH, the lower will be the machine productivity. However, the Arbomatik processor is designed to process small size trees and consequently may be somewhat less affected by variation in DBH within the usual commercial range.

The stand density per acre also affects machine productivity, thus affecting profitability and applicability. The tree harvester must move

through the woods, placing itself so as to reach as many trees as possible from one position. The lower the number of trees per acre, the more "unproductive" time the machine must spend in travelling through the woods. Although this factor restricts the applicability of the tree harvester, the Arbomatik processor, which operates at a landing where trees have already been accumulated, is not directly affected. The skidder, which brings the full trees to the Arbomatik, is subject to the density factor, but the skidder is designed for travelling and so the total influence of wood density per acre on an Arbomatik processor is not as great as on the tree harvester.

Soil condition limits the applicability of machinery in logging operations. Soil which is soft because of moisture or composition cannot be traversed by heavy machinery such as a tree harvester. Soft soil also limits the use of the lighter skidder but to a lesser extent than it does the 30-ton harvester. Obstacles, such as rock outcrops, interfere with the movement of machinery in the woods and consequently reduce productivity.

Other terrain conditions restrict the use of mobile woods equipment. The slope of the land severely limits machinery applicability. Tree harvesters cannot operate on slopes in excess of 20 per cent because of the high-reaching mast which would cause the machine to tip over on a greater than 20 per cent gradient. Skidders or forwarders are vastly less limited because of their low centre of gravity and articulated frames and the semi-stationary Arbomatik processor is not directly affected at all.

Once the influence of these variables on the introduction and extent of diffusion of an innovation into logging operations has been determined and the industry diffusion level itself has been derived, it is possible to estimate the manpower effects of the innovations. An assessment can be made of the number and occupations of the men who will be displaced, of the extent of the demands for new and expanding occupations, and of the rates at which these changes will take place.

Estimates for 1970 and 1975

This section begins by estimating pulpwood production in 1970 and 1975 for Eastern Canada, Ontario, Quebec and the Atlantic (Newfoundland and New Brunswick) provinces. Next, the provincial machinery diffusion levels are predicted for 1970 and 1975. Third, the anticipated autumn occupational distribution per modular unit (approximately 77,400 cunits) associated with the Arbomatik processor and Beloit tree harvester logging methods, and with logging methods where neither of the machines operates, is calculated. Finally, the machinery diffusion levels and the

expected occupational distributions are tied together and estimates are made of the employment and occupational distribution of the pulpwood logging industry for Eastern Canada for the fall of 1970 and of 1975.

Pulpwood Production, 1970 and 1975

Pulpwood is used by the pulp and paper industry as an input for the production of newsprint, market wood pulp and other paper products. The amount of pulpwood required by the industry depends, in large part, upon the demand (both domestic and foreign) for its pulp and paper production. Ideally, a detailed analysis of this demand for pulp and paper should be carried out before predicting pulpwood production. Limited time and resources have prevented such an analysis for this report. Use has therefore been made of previous demand studies.

The available views and studies can be divided into two groups. One group consists of the widely accepted predictions made in the Gordon Commission's outlook for the Canadian forest industries[10] and the other group comprises a more recent set of views which suggest a much higher growth rate. It is difficult to say which of the two growth rates will be correct and we have not been able to undertake the extensive examination necessary to develop our own forecast.[11] In this report the implications of both rates will be examined.

A Regional Pulpwood Forecast Derived from the Modified Gordon Commission Output Estimates: The Gordon Commission made a detailed forecast of the demand for the various products of the pulp and paper industry for each five-year interval between 1960 and 1980.[12] Pulpwood and wood residue requirements have been derived from the product forecasts by applying the Gordon Commission conversion factors[13] to the predicted increases in the products and by including interpolated estimates for pulpwood exports.[14] For 1970 and 1975 then, it is estimated that the Canadian industry will produce, respectively, about 20.4 and 22.8 million cunits of pulpwood and residue. This means that the 1965 pulpwood production and residue consumption figure would have to increase by 2.5 per cent per year compounded annually to reach the derived pulpwood and residue forecast for 1975. Between 1965 and 1970 the implicit growth rate is 2.6 per cent per annum. Recently, a re-examination of the Commission forecast by one of the authors, Dr. Paul E. Lachance, has indicated that the forecast is still substantially valid.[15] In 1963 pulpwood production and residue consumption was slightly below the Gordon Commission trend, but in 1964 and 1965 the actual figures were somewhat above trend.

The only relevant area in which the Commission forecast appears to have erred was in the use of wood residue at the mills. Residue consumption has risen much more rapidly than the Commission anticipated; the actual wood residue utilization in 1965 was approximately one-third greater than the 1980 prediction. A separate wood residue forecast has consequently been derived from an examination of the past and likely future production of sawn products and of the relationship between the output of sawn wood and residue utilization, and is presented, along with pulpwood forecasts, in Table 7. For Eastern Canada the ratio of residue utilization to production of sawn products has been constant but is expected to increase somewhat.[16] In British Columbia the ratio has been rising and is expected to continue to rise to 1975. Hence, Canadian industry consumption of residue is expected to reach 4.6 million cunits in 1970 and 5.9 million cunits in 1975, as contrasted with 4.2 in 1965. Eastern Canadian residue consumption in 1970 is expected to be 1.3 million cunits, and British Columbia consumption 3.3 million cunits, while in 1975 the figures are estimated at 1.5 and 4.3 million cunits, respectively.

Regional pulpwood and wood residue forecasts have been derived from the wood residue estimates and an analysis of East-West trends in pulpwood and residue production and of proposed developments in each area. It should be noted, however, that the overall Gordon Commission output estimates for 1970 and 1975 are not sufficiently large to accommodate all the present industry plans for new British Columbia mill capacity at rates of capacity utilization approaching those which are now current. Consequently, the regional estimates derived from the overall Gordon Commission estimates produce much slower growth in that area than do estimates which assume fulfillment of present mill expansion programs with substantially constant capacity utilization ratios.

In Eastern Canada in 1970 pulpwood production and residue consumption is expected to reach 13.5 million cunits as compared with an estimated 14.2 million cunits in 1975. For the same years pulpwood production will probably be 12.2 and 12.7 million cunits, respectively. In British Columbia pulpwood production and residue consumption is expected to be 5.8 million cunits in 1970 and 7.4 million cunits in 1975. Its anticipated pulpwood production for these years is 2.5 and 3.1 million cunits, respectively. For the "Other" category (Prairies, Nova Scotia and Prince Edward Island) pulpwood and residue (mainly pulpwood) figures of 1.1 and 1.2 million cunits are expected for 1970 and 1975, respectively.

Table 8 subdivides the Eastern Canadian pulpwood forecast into limit and non-limit[17] production and shows the distribution among Ontario,

Table 7. Pulpwood Production and Wood Residue Consumption, Canada and Regions—Actual, 1964 and 1965—Forecast, 1970 and 1975

(Modified Gordon Commission Output Estimates)

	1964			1965			1970			1975		
	Pulpwood	Residue	Total	Pulpwood†	Residue	Total	Pulpwood	Residue	Total	Pulpwood	Residue	Total
	(thousands of cunits)											
Canada	14,585	3,196	17,781	14,760	4,168	18,928	15,800	4,600	20,400	16,900	5,900	22,800
Eastern Canada	11,480	1,013	12,493	11,200	1,139	12,339	12,200	1,300	13,500	12,700	1,500	14,200
British Columbia	2,051	2,117	4,168	2,370	2,951	5,321	2,500	3,300	5,800	3,100	4,300	7,400
Other**	1,054	*	1,120	1,190	*	1,268	1,100	*	1,100	1,100	100	1,200

*Less than 100,000 cunits.
**Includes Prairies, Nova Scotia and Prince Edward Island.
†Estimated pulpwood production for 1965.
SOURCE: D.B.S. *Pulpwood and Wood Residue Statistics*, December 1964 and December 1965, and D.B.S. *Trade of Canada, Exports*, December 1965.

Table 8. Estimated Company Limit and Non-Limit Pulpwood Production in Eastern Canada and Provinces, Average, 1964 and 1965, Forecast, 1970 and 1975

(Modified Gordon Commission Output Estimates)

Province	Average 1964 and 1965			1970			1975		
	Total	Limit	Non-Limit	Total	Limit	Non-Limit	Total	Limit	Non-Limit
	(millions of cunits)								
Eastern Canada....	10.6	7.0	3.6	12.2	8.3	3.9	12.7	9.4	3.3
Ontario............	3.3	2.0	1.3	3.8	2.5	1.3	3.9	2.9	1.0
Quebec............	5.3	3.6	1.7	6.1	4.0	2.1	6.4	4.5	1.9
Atlantic*..........	2.0	1.4	0.6	2.3	1.8	0.5	2.4	2.0	0.4

*Includes Newfoundland and New Brunswick.

Quebec and the Atlantic region. The distribution among provinces was made on the basis of an examination of post-war ratios of provincial pulpwood figures to the Eastern Canadian totals. From 1945 to 1951 the Atlantic ratio increased very rapidly while the Quebec ratio declined noticeably. From 1951 to 1964, however, all three provincial ratios have shown very little variation and it is assumed that they will continue substantially unchanged to 1970 and 1975.

In recent years, the non-limit to total pulpwood ratios have been running close to 40 per cent in Quebec and a little over 35 per cent in Ontario. In the Atlantic region, ratios are averaging about one half of the Quebec and Ontario levels. With the continuing consolidation of farm holdings and movement of farmers from rural areas to places of new employment, it is anticipated that the supply of farm woodlot manpower and manpower for limit operations as well will tend to decline over the next ten years. Also, with the expected technological changes in company pulpwood logging operations, the real cost of limit wood is expected to fall relative to the real cost of non-limit pulpwood. This shift in relative real costs will occur because of the substantial technological change expected to take place on company limits—introduction of expensive, high-capacity machines which most woodlot operators are not expected to be able to finance or utilize to full capacity. These technological changes will probably have little influence on non-limit production in the next five years but

between 1970 and 1975 the changes will probably improve limit wood costs sufficiently, relative to the non-limit wood costs, to cause a reduction in non-limit production. Certainly these considerations would seem to preclude any substantial long-term increase in non-limit production. The ratios are expected to decline in Quebec and Ontario to slightly over one-third in 1970 and to between 26 and 30 per cent in 1975. Little change is anticipated in the Atlantic region which is already heavily dependent on limit wood.[18]

A Regional Pulpwood Forecast Derived from a Six Per Cent Growth Rate Output Estimate: A higher growth rate than forecast by the Gordon Commission would appear to be anticipated by the first annual report of the Economic Council of Canada, at least to 1970. The Economic Council estimated that, if its general goals for the economy are met, primary forest output will grow at a compound annual rate of about 4 per cent between 1963 and 1970. In view of the general expectation that lumber production will expand more slowly than pulp and paper production, this would seem to imply a growth rate for Canadian pulpwood and wood residue considerably in excess of 4 per cent. Current industry plans in British Columbia —mills under construction, planned mills with harvesting licenses secured, and planned mills for which licenses have not yet been secured—call for capacity in that area to double by 1970 and treble by 1975. At the same time, industry sources suggest that output of pulpwood and wood residue east of the Rockies (which grew very slowly between 1954 and 1963) may expand at a much more rapid rate in the future. Many suggest that an appropriate compound growth rate between 1963 and 1970 would be in excess of 4 per cent even east of the Rockies, but that slower growth (in the neighbourhood of 3 per cent) might be expected thereafter.

For comparative purposes, these recent views have been combined into a single, highly eclectic "forecast". This "forecast", it must be emphasized, represents no more than a collection of currently plausible views and is not the result of a unified and careful appraisal of demand prospects. Combining these views produces a growth rate of approximately 6 per cent per annum from 1965 to 1975 for pulpwood and residue (Table 9). Pulpwood production and wood residue consumption is estimated to be 26.7 million cunits in 1970 and 34.1 million cunits in 1975. For Eastern Canada the figures are 14.6 and 17.3, for British Columbia 10.7 and 15.2 and for "Other" 1.4 and 1.6.

By a process similar to that described in the previous section, limit and non-limit production figures were derived for Eastern Canada and its sub-

Table 9. Pulpwood Production and Wood Residue Consumption, Canada and Regions—Actual, 1964 and 1965—Forecast, 1970 and 1975

(A Six Per Cent Growth Rate Output Estimate)

	1964	1965**	1970	1975
	(thousands of cunits)			
Canada	17,781	18,928	26,700	34,100
Eastern Canada	12,493	12,339	14,600	17,300
British Columbia	4,168	5,321	10,700	15,200
Other*	1,120	1,268	1,400	1,600

*Includes Prairies, Nova Scotia and Prince Edward Island.
**Estimated pulpwood production for 1965.
SOURCE: D.B.S. *Pulpwood and Wood Residue Statistics,* December 1964 and December 1965, and D.B.S., *Trade of Canada, Exports,* December 1965.

divisions and are presented in Table 10. These estimates show strong increases in limit production in all provinces over the ten-year period. Non-limit pulpwood production increases in all areas from 1964-1965 to 1970 but then remains relatively constant to 1975.

The modified Gordon Commission estimates and the eclectic 6 per cent forecast show very different output levels for Canada as a whole in

Table 10. Estimated Company Limit and Non-Limit Pulpwood Production in Eastern Canada and Provinces, Average 1964 and 1965, 1970 and 1975

(A Six Per Cent Growth Rate Output Estimate)

Provinces	Average 1964 and 1965			1970			1975		
	Total	Limit	Non-Limit	Total	Limit	Non-Limit	Total	Limit	Non-Limit
	(millions of cunits)								
Eastern Canada	10.6	7.0	3.6	13.2	8.9	4.3	15.9	11.8	4.1
Ontario	3.3	2.0	1.3	4.1	2.7	1.4	4.9	3.7	1.2
Quebec	5.3	3.6	1.7	6.6	4.3	2.3	8.0	5.6	2.4
Atlantic*	2.0	1.4	0.6	2.5	1.9	0.6	3.0	2.5	0.5

*Includes Newfoundland and New Brunswick.
Figures may not add up due to rounding.

Table 11. A Comparison of the Limit Production Estimates Derived from the Modified Gordon Commission and Eclectic Growth Rate Output Estimates Eastern Canada and Provinces, 1970 and 1975

	Average 1964 and 1965	1970		1975	
		Modified Gordon Commission	Eclectic	Modified Gordon Commission	Eclectic
	(millions of cunits)				
Eastern Canada......	7.0	8.3	8.9	9.4	11.8
Ontario..............	2.0	2.5	2.7	2.9	3.7
Quebec.............	3.6	4.0	4.3	4.5	5.6
Atlantic*...........	1.4	1.8	1.9	2.0	2.5

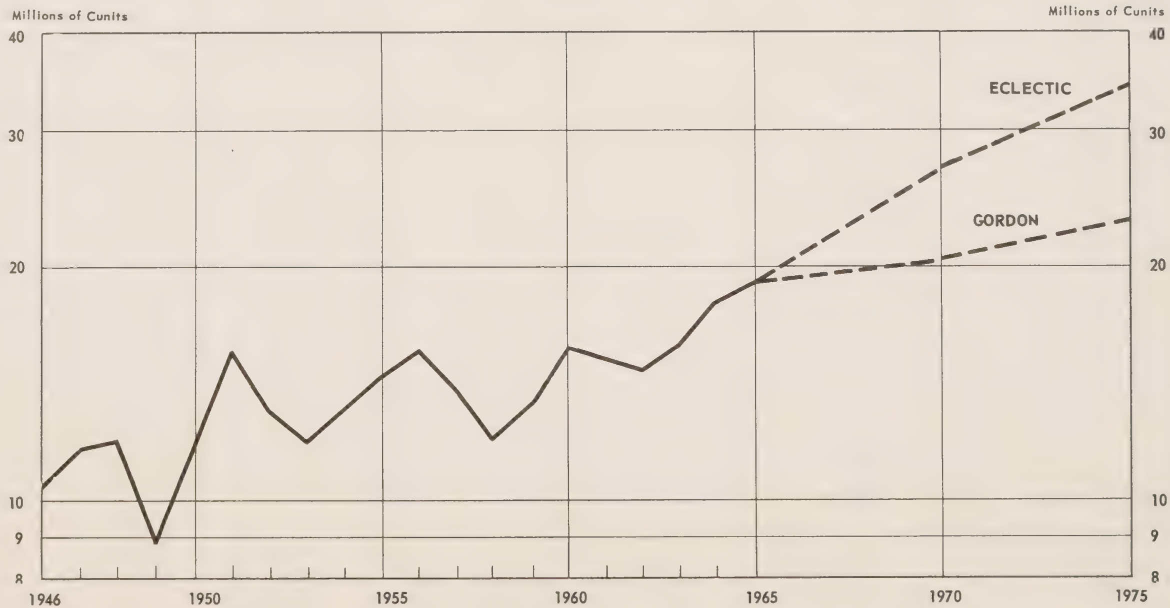
*Includes Newfoundland and New Brunswick.

1970 and 1975 (Figure 27). Since much of the difference between the two forecasts reflects different assumptions about the growth rate in British Columbia, the differences in Eastern Canada are significantly smaller. As Table 11 shows, the difference in Eastern Canada limit production is less than 10 per cent in 1970, and about 20 per cent in 1975.

Although the Gordon Commission estimates have performed well to date, there is, as noted above, a substantial difference between the output levels predicted by the Commission and those implied by current industry expansion plans. It is possible, of course, that there is no conflict between the two—the percentage of capacity utilized could fall sufficiently to provide a Gordon Commission output level even with the greatly expanded mill construction plans. This rather academic possibility seems remote, however, and it appears more likely that production figures may be above the Gordon Commission trend and actual mill construction below the level currently anticipated.[19] While it is impossible to be certain, it appears unlikely that the actual figures will fall significantly below the Gordon Commission estimates, or rise significantly above the current higher output assumption. However, it must be noted that pulpwood production is subject to a very large degree of year-to-year variability—10 per cent swings are by no means uncommon. The two output estimates used here should be understood as attempts to represent the trend, rather than as forecasts of the specific situation prevailing at a point which lies some years ahead in time.

Figure 27

PULPWOOD PRODUCTION AND WOOD RESIDUE CONSUMPTION
CANADA, ACTUAL, 1946–1965, FORECAST, 1970 AND 1975



Source: D.B.S., **THE PULP AND PAPER INDUSTRY,** *1946–1962,* **PULPWOOD AND WOOD RESIDUE STATISTICS,** *December 1961–December 1965, and unpublished statistics.*

Extent of Diffusion—1970 and 1975—Modified Gordon Commission Output Estimates

The discussion of the theoretical and analytical considerations in Section A has set the framework for the inquiry into the company limit diffusion rates of the new pulpwood logging machinery and into the manpower implications resulting from the spread of these innovations into the Eastern Canadian company limit operations. The present subsection provides estimates of diffusion levels, numbers of machines, and volumes of machine production for 1970 and 1975 based on the modified Gordon Commission output estimates.

A number of different situations can arise with respect to diffusion of the Arbomatik processor and Beloit tree harvester. It is conceivable, although probably unrealistic, that both machines could fail in testing and that neither of them will be used on Eastern Canadian logging operations. Or one machine may be successful while the other fails.[20] The final possibility is that both machines will prove to be successful and that both will spread through company limits. It is the latter eventuality which appears to be, at this time, the most probable event. Both machines, by company and manufacturer reports, seem to be on the verge of commercial application and consequently, diffusion estimates will be presented for both machines on the assumption that both will be successful. These estimates are based on the assumption—which is unlikely to be correct—that the Arbomatik processor and Beloit harvester methods will be the only commercial fully mechanized methods in the next few years. At a later point this assumption is relaxed and the potential impact of the other methods is discussed.

There are four major elements which must be considered in order to derive diffusion rates for the two machines: the amount of time still required to make the machines fully commercial; the advantages of the systems when operational; the ultimate extent of their use; and the timepath by which that extent will be reached.

Both the Arbomatik processor and the Beloit tree harvester are currently in the latter stages of development. Discussions with those closely in touch with the situation suggest that the remaining mechanical difficulties of the Arbomatik will be resolved shortly and that the six developmental models will be in commercial use by the spring of 1967.[21] It is assumed here that these anticipations will prove to be correct. It must be remembered, however, that expectations of this sort frequently err on the side of optimism. Development of new and complex machinery is an extraordinarily difficult and challenging task, subject to unforeseen delays. Since

it is almost always possible to make further improvements in mechanical equipment, those in charge of development are continually faced with the alternatives of freezing the design and commencing production or making further design improvements and postponing commercial introduction. The decision as to when to shift into production is one which involves a complex array of highly imponderable variables.

The Arbomatik is currently capable of processing full trees at the rate of nearly 6.5 cunits per operating hour.[22] There appear to be good prospects for significant increases in operating speed with consequent lowering of unit cost and labour requirements. It is possible that the eventual productivity ceiling will be determined more by the skill of the operators than by the limits of the equipment. For the purpose of estimating the extent of diffusion and labour requirements, *average* operating rates of 6.5 cunits per hour in 1970 and about 7.5 cunits per hour in 1975 have been assumed. These assumptions may prove to be unduly conservative—it is certainly possible that eventual rates will be higher.

Development of the harvester began some years ago as a result of research carried out by Marathon Corporation of Canada. Since 1962, the major development of the harvester method has rested in the hands of the Beloit International (Canada) Limited, an equipment manufacturer, although one pulp and paper company has continued development of its own model. The continuation of development on the machine has thus come to be largely, but not entirely, centralized as has the development of the Arbomatik processor. Of the six harvesters being tested in the fall of 1965 by four companies in Eastern Canada,[23] five were the products of the Beloit International (Canada) Limited.[24]

To date, the major problem with the Beloit harvester has been not its performance when working, but the low percentage of time during which it has been able to operate. Like all new and complex machinery, the harvester has been subject to frequent mechanical breakdowns. Before the harvester can begin to achieve its potential, these difficulties must be eliminated, and the availability of the machine for steady use vastly increased. The time necessary for the "debugging" of the machine is difficult to assess. In order to estimate the diffusion rate of the machine it has been assumed that this process will have been completed in early 1968 and that the harvester will shortly thereafter be available in reasonable quantities.

The Arbomatik and the harvester perform very different functions and it is therefore not possible to make a direct comparison of the two machines. Both units are designed to be used with other equipment, not in isolation, and the relevant comparison is therefore method versus method rather than

machine versus machine. Unfortunately, full comparisons of the proper sort cannot be made until both systems are fully operational and have been used under a wide variety of environmental conditions.

It is expected that the Arbomatik processor methods will be more widely used in Eastern Canada than harvester methods. Use of the harvester is restricted to areas where, under suitable conditions, the soil is capable of bearing its great weight. In addition, the relatively high centre of gravity and extended mast boom of the harvester seriously impede its operations on moderate to steep slopes and effectively prevent its use when slopes exceed 20 per cent. Since the Arbomatik processor is semi-stationary[25] it is not directly affected by terrain or soil conditions. The full-tree skidder or feller-skidder which will be used to bring full trees to the Arbomatik processor is affected by terrain or soil conditions, but to a vastly lesser extent than the harvester. In the extensive forest areas of Eastern Canada which have less than ideal conditions, the Arbomatik method is expected to prove more suitable than the harvester method; in some areas an Arbomatik will be used under conditions which would make use of a harvester virtually impossible.

These conditions are, not surprisingly, reflected to some degree in the current pattern of experimentation and use of the two machines in Eastern Canada. Most of the Beloit harvesters on company limits have been located in Ontario which has, in general, more suitable terrain and stand conditions for the harvester than other areas in Eastern Canada. However, some new machines are scheduled for use in Quebec and New Brunswick. The organization responsible for development of the Arbomatik processor, the Logging Research Associates, is a joint venture of three companies, all of which possess limits in Quebec where conditions are generally more suitable for Arbomatiks than for harvesters. The substantial degree of future use of the Arbomatik in Ontario is, however, foreshadowed by the current development pattern. Of the six Arbomatik models now being tested, four are operating in Ontario and two in Quebec.

A considerable volume of information is available concerning terrain and stand conditions in the different portions of Eastern Canada.[26] Much of this information is too general to be of any considerable value in estimating the possible ultimate extent of diffusion of the Arbomatik processor and Beloit harvester methods. A thorough evaluation of the probabilities would require a detailed assessment of all the relevant characteristics and the construction of a cost array of forest areas for each method. Such an assessment, with the characteristics of the new machinery in mind, has not been carried out. Some companies have, however, made assessments of

their own limits with regard to applicability of the new methods. These assessments run the gamut from detailed, almost acre-by-acre studies to broad and necessarily imprecise generalizations about applicability over wide areas. Study of the available public information and the likely limits of the new equipment, and discussions with company officials suggest that the economic applicability of the Arbomatik method is likely to be more widespread than that of the harvester method. Very roughly, it would appear that the Arbomatik could effectively operate in about 90 per cent of the limit cutting areas in Ontario, and about 80 per cent in Quebec and the Atlantic area. Similarly, it is estimated that the harvester could ultimately produce nearly 40 per cent of the annual limit cut in Ontario and about 10 per cent in each of Quebec and the Atlantic regions. These "ultimate" diffusion levels for the Arbomatik and harvester should be regarded as very rough potential approximations.[27] Although they have been derived by considering carefully all the available information, the simple fact is that the extent of that information is limited. Also, these estimates depend largely on the fulfillment of expectations which may not come to fruition. They are thus, at best, highly conjectural.

The time path of diffusion of the harvester and Arbomatik is expected to approximate the classic "S" curve of innovation. The history of mechanical invention shows that, once a new technique is available, its use grows slowly at first, then accelerates rapidly and finally tapers off at a level approximating the ultimate extent of diffusion. This pattern has been observable in the pulpwood logging industry as well as elsewhere. The power saw was introduced into commercial use in the Eastern Canadian pulpwood logging industry in 1951. In the first couple of years, diffusion was slow but by 1958, i.e., after a period of seven years, the saw had permeated the entire Eastern Canadian pulpwood logging industry. Another new piece of machinery, the rubber-tired skidder, was first used in the Eastern Canadian forests in 1959. From 1959 to 1962, there was very little spread of this machine into the logging operations of Eastern Canada. From 1962 to date, however, the increase in the use of these skidders has accelerated very rapidly. Another three years will probably elapse before the rate of increase tapers off, with production after that time being mainly for replacement. Consequently, about nine or ten years are expected to be needed to achieve the ultimate extent of diffusion of these skidders on limit operations.[28]

The fundamental reasons underlying the slow initial start and later acceleration were discussed earlier in this chapter and are expected to apply to both the Arbomatik and the Beloit harvester. For both machines a reasonable diffusion period appears to be of the order of eight to ten years

from the date of commercial availability, although for different reasons. Initially, the Arbomatik will probably be used mainly by the LRA companies which have participated in its development. As they increase their use of it, an increasing number of non-LRA companies can be expected to purchase machines—use of the machines by the LRA companies will be one factor encouraging others to imitate. If previous experience is relevant, the first non-LRA purchasers will be the larger outside firms. They will be followed by the smaller firms. The harvester will initially be used by the four companies which are currently experimenting with the machine. As the extent of diffusion of the tree harvester into their limits rises, it is probable that other companies will make purchases, following the pattern of expected Arbomatik developments. The diffusion of both machines will be aided by the probable further increases in their efficiency. Development of a fully commercial feller-skidder and/or self-loading skidder should be completed within the next three years and this should add impetus to the spread of the Arbomatiks with which they will be used.[29] The development of a commercial grapple-skidder in the next few years should add impetus to the diffusion of the harvester.[30]

As indicated, regional differences in the spread of Arbomatik and Beloit harvesters are expected with regard to the "ultimate" diffusion levels of 1975. Some differences in the regional time patterns is also to be expected. The suitability of both the harvester and Arbomatik methods in large areas of Ontario may, somewhat paradoxically, tend to slightly retard development in that area. The existence of alternatives serves to increase uncertainty and some firms may well be inclined to adopt a "wait and see" attitude. To a degree, however, this will be counterbalanced by the higher wage rates prevailing in Ontario which will offer greater incentive to mechanization than will prevail in Quebec or the Atlantic area.

Consideration of the various factors has led to the diffusion rate estimates for 1970 and 1975 which are presented in Table 12. It is expected that the harvester, by 1970, will process about 7 per cent of all limit production in Eastern Canada and about 18 per cent in 1975. By 1970 the Arbomatik is expected to have achieved nearly one third of its 1975 diffusion level of 65 per cent. There is, for both the Arbomatik and the harvester, a considerable amount of interprovincial variation both in the estimated diffusion in 1975 and the proportion of the 1975 level which will be achieved by 1970.

The table also presents estimates of the number of Arbomatiks and harvesters in use in the two forecast years. Moreover, these estimates are based on the assumption of a two-shift operation of the machines. Recently

Table 12. Arbomatik Processor and Tree Harvester—Extents of Diffusion, Numbers of Machines, and Machine Pulpwood Production on Company Limit Operations, Eastern Canada and Provinces, 1970 and 1975

(Modified Gordon Commission Output Estimates)

Province	Arbomatik Processor						Tree Harvester					
	1970			1975			1970			1975		
	Extent of Diffusion	Number of Machines	Machine Production	Extent of Diffusion	Number of Machines	Machine Production	Extent of Diffusion	Number of Machines	Machine Production	Extent of Diffusion	Number of Machines	Machine Production
	(per cent)		(millions of cunits)	(per cent)		(millions of cunits)	(per cent)		(millions of cunits)	(per cent)		(millions of cunits)
Eastern Canada..	20	71	1.66	65	227	6.12	7	36	0.55	18	92	1.69
Ontario..........	13	15	0.35	52	56	1.51	15	26	0.39	38	60	1.10
Quebec..........	25	43	1.01	71	118	3.19	3	7	0.11	9	22	0.41
Atlantic*	16	13	0.30	71	53	1.42	3	3	0.05	9	10	0.18

*Includes Newfoundland and New Brunswick.

at least one company has apparently been testing a harvester on a three-shift basis. Should the advantages of three-shift operation be sufficient to overcome the drawbacks—the probable need for differential shift pay, complication of maintenance operations, and the difficulties of night work in the woods—the number of machines would be reduced by one-third. This reduction in the number of machines would have no significant impact, however, on the amount of labour required per unit of output, and therefore no significant impact on the occupational estimates presented below.

These estimates, as noted, are also based on the assumption that no other major pieces of equipment become commercial realities within the time period covered. This assumption is almost certain to prove to be erroneous. The chip pipeline is not expected to be a major influence by 1970, but might well affect the estimates by 1975. If, as it now seems not unreasonable to expect, the pipeline is used primarily to convey wood in chip form from final landings to mills, it will not have any significant impact on these estimates even by 1975.[31] In addition, it must be remembered that a chip pipeline involves a much bigger financial commitment (currently estimated at about $7 million for a 50-mile line) than the Arbomatik processor or Beloit harvester. The size of the financial commitment involved, and the extent of reorganization of facilities needed to go with it, will tend to give it a rather long diffusion period.

Despite the potential revolutionary impact of the chip pipeline on the transportation segment of the industry, the major potential threat to the diffusion estimates appears to come from the Koehring processor and the Sund Processing System, described above. Test data are not yet available on the Koehring processor and data on the Canadian test performance of the Sund Processing System[32] are limited and it is therefore not possible to make any estimate of their success or lack of success. In contrast with the chip pipeline, they would obviously be in direct competition with the Arbomatik and harvester. What their take-over share of the market would be, and when, are unanswerable questions for the time being. Should their development rate approximate that of the Arbomatik and harvester, it would appear that it will be a number of years before efficient trouble-free models are available for general use.[33] If that proves to be the case (although there is obviously no reason why it must) the machines would not reach the commercial stage until about 1969 or 1970, and would thus have little or no impact on the 1970 diffusion levels of the Arbomatik and harvester. By 1975, however, there would have been ample time for a successful Koehring processor or Sund Processing System to cut a wide swath through the Eastern Canadian forests. A brief discussion of the occupational modifications which would be likely to result from widespread

use of the machines is provided in conjunction with the occupational estimates below.

Extent of Diffusion—1970 and 1975—A Six Per Cent Growth Rate Output Estimate

In the discussion of the 6 per cent growth rate above it was estimated that most of the additional pulpwood production resulting from this higher growth rate will come from company limit operations. With this higher limit/non-limit ratio it is conceivable that company operations may shift toward previously unexploited pulpwood logging areas where the Arbomatik or the harvester can be more readily applied. Such a move could result in somewhat higher company limit diffusion rates and levels for the new machine. Although the existence of this factor is acknowledged, lack of suitable environmental information renders estimation of its significance impossible.

Accordingly, the diffusion levels which were estimated in subsection (b) for the modified Gordon Commission growth rate are assumed to hold for the 6 per cent rate of growth. It is obvious that, at the same rates of machine diffusion, a larger growth rate implies more machines and more machine production. It is implicitly assumed that the companies will find it profitable to purchase the extra machines and that they will be financially capable of doing so.[34] Table 13 presents the unchanged diffusion levels and the new figures for the numbers of machines and machine production.

The diffusion level of the Arbomatik processor for 1970 and 1975 is highest in Quebec and the Atlantic while the extent of diffusion for the Beloit tree harvester for both years is highest in Ontario, which contains logging stands with substantially level terrain for which the tree harvester is specifically designed. About three-fifths of the 76 Arbomatik processors predicted for 1970 should be operating in Quebec. Of the nearly 40 harvesters, two-thirds to three-quarters will probably be located in Ontario. By 1975 the distribution will have changed somewhat. Slightly over half of the 285 Arbomatiks will be in Quebec, with the remainder almost equally divided between Ontario and the Atlantic region. In that year, about two-thirds of the 115 harvesters will be processing trees in Ontario, almost one-quarter will be operating in the woods of Quebec and over 10 per cent will be producing pulpwood in the Atlantic forests.

Autumn Occupational Distribution per Modular Unit, 1964-1965, 1970 and 1975

Forecasts of machine output were made above based on the two growth assumptions and the various assumptions concerning the new

Table 13. Arbomatik Processor and Tree Harvester—Extents of Diffusion, Numbers of Machines and Machine Pulpwood Production on Company Limit Operations, Eastern Canada and Provinces, 1970 and 1975

(A Six Per Cent Growth Rate Output Estimate)

Province	Arbomatik Processor						Tree Harvester					
	1970			1975			1970			1975		
	Extent of Diffusion	Number of Machines	Machine Production	Extent of Diffusion	Number of Machines	Machine Production	Extent of Diffusion	Number of Machines	Machine Production	Extent of Diffusion	Number of Machines	Machine Production
	(per cent)		(millions of cunits)	(per cent)		(millions of cunits)	(per cent)		(millions of cunits)	(per cent)		(millions of cunits)
Eastern Canada.	20	76	1.78	65	285	7.69	7	38	0.58	18	115	2.12
Ontario..........	13	16	0.37	52	71	1.92	15	27	0.41	38	76	1.41
Quebec..........	25	46	1.09	71	148	3.98	3	8	0.12	9	27	0.50
Atlantic*........	16	14	0.32	71	66	1.79	3	3	0.05	9	12	0.21

*Includes Newfoundland and New Brunswick.

logging methods. In the present section, estimates of the autumn non-office occupational distribution per unit of production for the conventional, Arbomatik and harvester methods for 1970 and 1975 are presented in the form of modular units.[35] In order to facilitate comparison, actual data for 1964 and 1965 have been averaged together and are presented in the same tables. It should be pointed out that these modular unit forecasts of occupational distribution are not forecasts of productivity increases in the usual sense, but estimates of the anticipated autumn occupational breakdown per 77,400 cunits for each method. The occupational totals would have to be adjusted for seasonal influences and turnover in order to produce explicit productivity estimates.

Occupational Distribution per Modular Unit on Conventional Logging Operations: Not all company limit logging operations are expected to be using Arbomatik processors or tree harvesters in 1970 and 1975. Nevertheless, changes in the modular unit occupational distribution are anticipated on those operations which continue to use conventional methods. From 1963 to 1975 there will be significant increases in the use of rubber-tired skidders and other mechanical wood-moving equipment to replace horses in hauling wood from the stump to the landing. Increased usage of this mechanical equipment will reduce the manpower required to move wood from the stump to the landing. With possible mechanical improvements in power saws and with increased efficiency anticipated in their utilization a noticeable drop in the number of pulpwood cutters is to be expected even in the absence of Arbomatik or harvester methods. The continuing trend from short-wood operations to tree-length operations will reduce the number of functions which the pulpwood cutter must perform and consequently, will also cause some reduction in the number of cutters required on logging operations. To some degree, these trends will be offset by declines in average weekly hours.

Table 14 presents the expected occupational distribution per modular unit for 1970 and 1975 on those Eastern Canadian logging operations which continue to use essentially conventional methods. The average 1964-1965 distribution was derived from the occupational statistics in Table A-1 and from available company limit production data.

Total non-office employees are expected to decrease from 350.83 per modular unit in 1964-1965 to about 293 in 1970 and 266 in 1975.

For pulpwood cutters, reductions from 188.68 per unit in 1964-1965 to about 160 in 1970 and 143 in 1975 are anticipated. This decline is attributable to an anticipated reduction in the number of functions per-

Table 14. Autumn Occupational Distribution per Modular Unit on Conventional Logging Operations—Average 1964 and 1965—Forecast 1970 and 1975

Occupation	Average 1964 and 1965		1970		1975	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total non-office employees....	350.83	100.00	293.3	100.0	266.1	100.0
Production workers...........	351.54	71.70	207.7	70.8	188.7	70.9
Pulpwood cutter...........	188.68	53.78	160.4	54.7	143.0	53.7
Truck driver...............	15.61	4.45	19.0	6.5	20.0	7.5
Skidder and tractor operator.	17.12	4.88	14.0	4.8	13.0	4.9
Teamster..................	7.06	2.01	0.8	0.3	–	–
Scaler.....................	6.39	1.82	6.4	2.2	6.4	2.4
Loader.....................	5.59	1.59	5.0	1.7	5.0	1.9
Roadman and swamper.....	7.60	2.17	1.1	0.4	0.5	0.2
Labourer, production.......	3.47	0.99	1.0	0.3	0.8	0.3
Maintenance and service personnel..................	32.97	9.40	30.6	10.4	27.4	10.3
Cook, cookee and choreboy..	15.20	4.33	12.8	4.4	11.0	4.1
Mechanic.................	5.09	1.45	7.9	2.7	7.9	3.0
Labourer, non-production...	7.66	2.18	5.4	1.8	4.0	1.5
Other maintenance and service personnel.........	5.01	1.43	4.5	1.5	4.5	1.7
Unspecified occupations.......	66.32	18.90	55.0	18.8	50.0	18.8

SOURCE: Average 1964 and 1965 occupational data compiled from Table A-1 and CPPA limit pulpwood production statistics.

formed by pulpwood cutters and to continuing improvements in the mechanical efficiency and use of power saws.

Teamsters are expected to disappear over the ten-year period. This can be ascribed largely to the replacement of horses by rubber-tired skidders and crawler tractors the use of which will be encouraged by a continuing decline in the horse population. Decreases in the number of wheeled-skidder and crawler-tractor operators are likely from 1964-1965 to 1975. Most of the decrease is attributed to the continuing supplanting of the crawler tractor by the vastly more maneuverable wheeled-skidder. The wheeled-skidder, with its articulated frame, needs little road preparation and, consequently, it is expected that the roadmen and swampers (who build and maintain skidding trails and clear ground of obstructions) will be almost eliminated by 1975.

Over the last fifteen years the proportions of the Canadian annual pulpwood production delivered to the mill by land and by water have remained substantially constant. In land deliveries, however, which represent over one-third of the total mill deliveries, there has been a noticeable shift from rail to truck. It is believed that this shift will continue during the next few years and for this reason the number of truck drivers increases over the ten-year period.[36]

The occupation "loader", because of mechanical improvements expected in loading equipment in the next few years, will probably fall from 5.59 per modular unit in 1964-1965 to approximately 5 in 1970 and will likely remain close to that level until 1975. The number of scalers is a direct function of output and will thus remain stable unless, as is likely, new methods of measurement, such as by weight, are adopted on a wide scale. As in other industries a general decline in the demand for unskilled labour, relative to semi-skilled and skilled labour, in the pulpwood logging industry has taken place and is expected to continue to 1975. Hence, production labourers will fall from 3.47 per unit in 1964-1965 to less than one in 1975.

Maintenance and service personnel per modular unit are expected to decline slightly from 1964-1965 to 1975. The numbers of cooks, cookees and choreboys are directly related to the size of the labour force to be serviced and will constitute about the same proportion of the woods labour force in the future as they do currently. Non-production labourers are also expected to drop somewhat as the general decline in the demand for unskilled labour continues. The "Other maintenance and service personnel" group of occupations will decrease very slightly because of an anticipated decline in blacksmiths, carpenters, handymen and sawfilers, four of the occupations included in this group. Increases are expected, however, in the number of mechanics per modular unit. The rise in the use of trucks and the use of more sophisticated hauling and loading equipment will account for this anticipated increase.

The unspecified occupations contain a substantial element of supervisory personnel, probably a large number of pulpwood cutters, and various other occupations. Supervisors are expected to rise slightly as a percentage of the woods labour force, but their numbers should decline relative to output. The number of pulpwood cutters should decline with respect to both variables. The net result of these considerations—which, in the absence of quantitative data, can only be guessed at—will probably be substantial stability of the unspecified group relative to the total, but a decline in relation to output.

Occupational Distribution per Modular Unit on Arbomatik Processor Logging Operations: The occupational distribution for units using an Arbomatik processor will be greatly different from that for units using a conventional method. The Arbomatik units will benefit both from the reduction in labour needs occurring because of continuing efficiency increases in the portion of the method which remains conventional, and from the vastly lower labour needs of the Arbomatik processor method itself.

Since the Arbomatik processor removes limbs, bucks, and barks trees at the landing, the only processing function remaining for the pulpwood cutter will be to fell trees. At the moment, felling consumes about 17 per cent or more of a cutter's time in the short-wood system, and about 41 per cent in a tree-length system.[37] Thus, use of an Arbomatik processor alone will reduce the amount of cutter labour by between 59 per cent and 83 per cent. In addition it is probable that by 1969 the feller-skidder will begin to take over the sole remaining function of the pulpwood cutter. Although the feller-skidder, with its own diffusion period and pattern, will probably not have a very great impact by 1970, it should cause a substantial further reduction in pulpwood cutters by 1975.

It is assumed that, in 1970, the Arbomatik processor will work two shifts, i.e., 3,600 hours per year, and will produce 6.5 cunits per hour. With two operators needed per shift per machine, 3.3 machines with 13.2 operators will be needed per modular unit in 1970 (Table 15).[38]

For 1975, the assumption has been made that an Arbomatik processor will process 27,000 cunits annually still using two men on the machine.[39] Consequently, for 1975, 11.5 Arbomatik operators per modular unit will be needed.

In the Arbomatik method of pulpwood production, skidders, because they must haul full trees with branches attached, are expected to skid 20-25 per cent fewer trees per load as compared with logging methods where branches are left in the stump area. Hence, relatively more skidders and skidder operators will be needed. Whereas, in 1970 and 1975, the number of skidder operators in the conventional modular unit was estimated to be 14 and 13, respectively, in the Arbomatik modular unit it is expected to be 18 and 14, respectively.

With the addition of the complex and sophisticated Arbomatik processor, and with more skidders in the Arbomatik modular unit, the number of mechanics is expected to be 12 in 1970 and 1975 as compared with 8 in the conventional modular unit for the same years.

Table 15. Autumn Occupational Distribution per Modular Unit on Arbomatik Processor Logging Operations—Average, 1964 and 1965—Forecast, 1970 and 1975

Occupation	Average 1964 and 1965		1970		1975	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total non-office employees....	350.83	100.00	187.5	100.0	141.9	100.0
Production workers...........	251.54	71.70	110.0	58.6	74.4	52.4
Arbomatik processor operator................	–	–	13.2	7.0	11.5	8.1
Pulpwood cutter...........	188.68	53.78	46.9	25.0	17.2	12.1
Truck driver...............	15.61	4.45	19.0	10.1	19.0	13.4
Skidder and tractor operator.	17.12	4.88	18.0	9.6	14.0	9.9
Teamster..................	7.06	2.01	–	–	–	–
Scaler.....................	6.39	1.82	6.4	3.4	6.4	4.5
Loader....................	5.59	1.59	5.0	2.7	5.0	3.5
Roadman and swamper.....	7.60	2.17	0.5	0.3	0.5	0.4
Labourer, production.......	3.47	0.99	1.0	0.5	0.8	0.6
Maintenance and service personnel..................	32.97	9.40	30.5	16.3	27.5	19.4
Cook, cookee and choreboy..	15.20	4.33	8.5	4.5	7.0	4.9
Mechanic.................	5.09	1.45	12.0	6.4	12.0	8.5
Labourer, non-production...	7.66	2.18	5.5	2.9	4.0	2.8
Other maintenance and service personnel.........	5.01	1.43	4.5	2.4	4.5	3.2
Unspecified occupations.......	66.32	18.90	47.0	25.1	40.0	28.2

SOURCE: Average 1964 and 1965 occupational data compiled from Table A-1 and CPPA limit pulpwood production statistics.

The other occupations in the Arbomatik modular unit have been estimated in the same way as that used in approximating occupational changes in the conventional modular unit.

Occupational Distribution per Modular Unit on Tree Harvester Logging Operations: The biggest occupational change occurring in the harvester logging method, as seen in Table 16, is the immediate disappearance of the pulpwood cutter. All of the processing operations of felling, limbing and topping normally carried out by the pulpwood cutter in conventional tree-length operations are now performed by the one-man harvester. Similarly, further reduction in the "Unspecified occupations" category is expected since it is believed that much of this group consists of pulpwood cutters. With an expected annual production per harvester in 1970 of 15,300 cunits

Table 16. Autumn Occupational Distribution per Modular Unit on Tree Harvester Logging Operations—Average, 1964 and 1965—Forecast, 1970 and 1975

Occupation	Average 1964 and 1965		1970		1975	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total non-office employees	350.83	100.00	114.4	100.0	109.6	100.0
Production workers	251.54	71.70	48.9	42.7	46.1	42.1
Harvester operator	–	–	10.0	8.7	8.4	7.7
Pulpwood cutter	188.68	53.78	–	–	–	–
Truck driver	15.61	4.45	19.0	16.6	19.0	17.3
Skidder and tractor operator	17.12	4.88	7.0	6.1	6.0	5.5
Teamster	7.06	2.01	–	–	–	–
Scaler	6.39	1.82	6.4	5.6	6.4	5.8
Loader	5.59	1.59	5.0	4.4	5.0	4.6
Roadman and swamper	7.60	2.17	0.5	0.4	0.5	0.5
Labourer, production	3.47	0.99	1.0	0.9	0.8	0.7
Maintenance and service personnel	32.97	9.40	26.5	23.2	24.5	22.4
Cook, cookee and choreboy	15.20	4.33	4.5	3.9	4.0	3.7
Mechanic	5.09	1.45	12.0	10.5	12.0	10.9
Labourer, non-production	7.66	2.18	5.5	4.8	4.0	3.7
Other maintenance and service personnel	5.01	1.43	4.5	3.9	4.5	4.1
Unspecified occupations	66.32	18.90	39.0	34.1	39.0	35.5

SOURCE: Average 1964 and 1965 occupational data compiled from Table A-1 and CPPA limit pulpwood production statistics.

(i.e., two shifts), it is estimated that about 5 harvesters and 10 harvester operators will be needed in 1970 per modular unit. In 1975, at an annual production of about 18,400 cunits per machine, 8.4 operators is the expected requirement.

One of the big advantages of the harvester is that it bunches tree lengths for skidding. Thus, it is not necessary for the skidder to stop at each tree stump to pick up a tree length. Instead, all the tree lengths can be choked or cabled (or picked up with a grapple attachment) to the skidder in one stop. The bunching of tree lengths reduces considerably the time needed per skidding trip. Hence, the "skidder and tractor operator" category in 1970 and 1975 is estimated at 7 and 6, respectively, as compared with 14 and 13 in the conventional modular unit.

Table 17. Autumn Occupational Distribution in the Pulpwood Logging Industry in Eastern Canada—Average, 1964 and 1965—Forecast, 1970 and 1975

(Modified Gordon Commission Output Forecast)

Occupation	Average 1964 and 1965		1970		1975	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total non-office employees....	32,042	100.00	27,912	100.0	19,080	100.0
Production workers...........	22,974	71.70	19,049	68.3	10,766	56.4
Arbomatik processor operator................	–	–	283	1.0	909	4.8
Harvester operator.........	–	–	71	0.3	183	1.0
Pulpwood cutter...........	17,233	53.78	13,627	48.8	4,298	22.5
Truck driver...............	1,426	4.45	2,038	7.3	2,328	12.2
Skidder and tractor operator.	1,564	4.88	1,537	5.5	1,505	7.9
Teamster..................	645	2.01	63	0.2	–	–
Scaler.....................	584	1.82	686	2.5	777	4.1
Loader.....................	511	1.59	536	1.9	607	3.2
Roadman and swamper.....	694	2.17	101	0.4	61	0.3
Labourer, production.......	317	0.99	107	0.4	97	0.5
Maintenance and service personnel..................	3,011	9.40	3,250	11.6	3,272	17.2
Cook, cookee and choreboy..	1,388	4.33	1,221	4.4	867	4.5
Mechanic.................	465	1.45	964	3.5	1,373	7.2
Labourer, non-production...	700	2.18	582	2.1	486	2.5
Other maintenance and service personnel.........	458	1.43	483	1.7	547	2.9
Unspecified occupations.......	6,057	18.90	5,613	20.1	5,041	26.4

SOURCE: Average 1964 and 1965 statistics obtained from Table A-1.

As in the Arbomatik modular unit, there will be 12 mechanics per unit in 1970 and 1975. The full mechanization of the various processing, handling and skidding operations of the pulpwood logging operation is the reason for the higher number of mechanics as contrasted with the number needed in the conventional modular unit.

The remaining occupations were derived on the basis of the same factors used in estimating the corresponding occupations in the conventional modular unit.

Autumn Occupational Distribution, 1964-1965, 1970 and 1975

The expected limit labour requirements of the Eastern Canadian industry by occupation for 1970 and 1975 are shown in Table 17 based on

the modified Gordon Commission output assumption. The corresponding data based on the 6 per cent growth assumption are given in Table 18. These figures have been derived by combining the diffusion forecasts, the output forecasts, and the modular unit occupational requirements.[40] It should be emphasized that these tables exclude office employees and, of course, the labour employed on farm woodlots.

With the modified Gordon Commission growth assumption, total non-office employees are expected to decline slowly from 32,042 in the autumn of 1964 and 1965 to 27,912 in the autumn of 1970, and then to drop rapidly, to 19,080 in the autumn of 1975 (See Table 17). Production workers are expected to drop from 72 per cent of the total in 1964-1965 to 56 per cent in 1975 with most of the decline in this group attributed to the rapid fall in the pulpwood cutters percentage from about 54 in 1964-1965 to about 22 in 1975. Offsetting, to some extent, this sharp drop in pulpwood cutters are the anticipated increases in Arbomatik, harvester and skidder operators. Maintenance and service personnel will rise from 9 per cent to 17 per cent over the ten-year period, with mechanics accounting for almost all of the increase.

For the 6 per cent growth rate output forecast (Table 18), total non-office employees are expected to diminish from 32,042 in 1964-1965 to 29,952 in 1970 and 23,942 in 1975. Pulpwood cutters are expected to drop from 54 per cent of the total in 1964-1965 to a little over 22 per cent in 1975. Maintenance and service personnel will rise from about 3,000 to nearly 4,100, mainly because of the forecast increase in mechanics.

These occupational estimates have been derived on the basis of the simplifying assumption that only the Arbomatik processor and the Beloit tree harvester will be introduced into the Eastern Canadian woods by 1975. It seems not unlikely, however, that the Koehring short-wood processor and the Sund Processing System currently being use-tested on company limits in Quebec, will be used on Eastern Canadian logging operations within the next ten years. Although the machines' impact by 1970 may be slight, by 1975 it could be highly significant. A successful processor or Sund unit would displace to some extent both the Arbomatik and harvester and perhaps replace some of the conventional logging methods.

The development and spread of these alternatives to the Arbomatik and harvester would probably result, in general, in an overall reduction in labour input of roughly the same order of magnitude as that described above. There would be a substitution of operators of the Sund or Koehring equipment for operators of the Arbomatik or harvester. However, because of the different design of the alternative systems, there would be some

Table 18. Autumn Occupational Distribution in the Pulpwood Logging Industry in Eastern Canada—Average, 1964 and 1965—Forecast, 1970 and 1975

(A Six Per Cent Growth Rate Output Estimate)

Occupation	Average 1964 and 1965		1970		1975	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total non-office employees	32,042	100.00	29,952	100.0	23,942	100.0
Production workers	22,974	71.70	20,446	68.3	13,506	56.4
Arbomatik processor operator	–	–	304	1.0	1,143	4.8
Harvester operator	–	–	75	0.3	230	1.0
Pulpwood cutter	17,233	53.78	14,632	48.9	5,386	22.5
Truck driver	1,426	4.45	2,185	7.3	2,922	12.2
Skidder and tractor operator	1,564	4.88	1,649	5.5	1,890	7.9
Teamster	645	2.01	68	0.2	–	–
Scaler	584	1.82	736	2.5	976	4.1
Loader	511	1.59	575	1.9	762	3.2
Roadman and swamper	694	2.17	108	0.4	76	0.3
Labourer, production	317	0.99	115	0.4	122	0.5
Maintenance and service personnel	3,011	9.40	3,486	11.6	4,108	17.2
Cook, cookee and choreboy	1,388	4.33	1,311	4.4	1,088	4.5
Mechanic	465	1.45	1,033	3.5	1,724	7.2
Labourer, non-production	700	2.18	624	2.1	610	2.5
Other maintenance and service personnel	458	1.43	517	1.7	686	2.9
Unspecified occupations	6,057	18.90	6,020	20.1	6,328	26.4

SOURCE: Average 1964 and 1965 statistics obtained from Table A-1.

shifts in the occupational mix. If the expectations of the manufacturer of the Koehring processor are fulfilled, however, the reduction in labour input resulting from the use of the Koehring processor will be significantly more substantial than with the other systems.

The Koehring processor and the tree harvester both operate in the stump area with the harvester limbing, topping, felling, and piling tree lengths. The Koehring processor will perform all these operations and the additional operation of bucking the tree into 8-foot lengths. As compared with the harvester logging method the Koehring processor logging method will require twice as many operators for its processor as are needed to operate the harvester. The Koehring processor method will need one-third

fewer skidder or forwarder operators and will practically eliminate the loaders and slashing crew required in the harvester method.

The Sund and Arbomatik methods of pulpwood logging are both full-tree methods, and the central pieces of equipment in both methods operate at the landing. Trees are felled either by pulpwood cutters or feller-skidders and are skidded to the landing with the branches still attached. Approximately the same number of personnel will be required to operate the Sund units as are needed to operate Arbomatik processors. There would be no other noticeable occupational differences between the two methods.

The advent of chip pipeline transportation from the final landing to the mill could, as noted, be expected to have a substantial impact on the number of truck drivers, with possible secondary impacts on other occupations.

REFERENCE NOTES

1. $\frac{d(D_t)}{dt}$ where d = derivative

2. $$D_t = \frac{\sum_{i=1}^{n} d_{it} \cdot P_{it}}{\sum_{i=1}^{n} P_{it}}$$ where d_{it} is the extent of diffusion of the innovation within the operations of the "i"th firm in period t and P_{it} is the "i"th firm's (pulpwood) production in period t.

3. Much of the following discussion draws heavily upon three papers written by Edwin Mansfield. These are *Technical Change and the Rate of Imitation,* Econometrica, Vol. 29, No. 4 (October, 1961), pp. 741-766; *The Speed of Response of Firms to New Techniques,* Quarterly Journal of Economics, Vol. LXXVII, No. 2 (May, 1963), pp. 290-311; and *Intrafirm Rates of Diffusion of an Innovation,* Review of Economics and Statistics, Vol. XLV, No. 4 (November, 1963), pp. 348-359.

4. However, it should be noted that some of the smaller firms in the Eastern Canadian pulp and paper industry have led the way in certain technological changes. For example, Marathon initiated the development of cable yarding, KVP was a pioneer with the Blue Ox skidder, and the slasher, and Dryden Paper Company, Limited, Ontario, developed the Tree Farmer skidder.

5. Mansfield, Edwin, *Technical Change and the Rate of Imitation,* Econometrica, Vol. 29, No. 4 (October, 1961), pp. 741-766.

6. The four industries were bituminous coal, iron and steel, brewing and railroads. The twelve innovations were shuttle car, trackless mobile loader, continuous mining machine, the by-product coke oven, continuous wide strip mill, continuous annealing line for tin plate, pallet-loading machine, tin container, high speed bottle filler, diesel locomotive, centralized traffic control and car retarder. The number of years elapsing before half the firms had introduced an innovation varied from 0.9 to 15 with an average of 7.8.

7. The rate of imitation I(t) may be defined as the proportion of "hold-outs" (firms not using an innovation) at time t that introduce the innovation by time t + 1, i.e.,

$$I(t) = \frac{m(t + 1) - m(t)}{n - m(t)}$$

where m(t + 1) is the number of firms having introduced the innovation at time t + 1,
m(t) is the number of firms having introduced the innovation at time t, and
n is the total number of firms in the industry being analysed (a constant).

8. Mansfield, Edwin, *Technical Change and the Rate of Imitation,* Econometrica, Vol. 29, No. 4 (October, 1961), pp. 741-766.

9. Mansfield, Edwin, *The Speed of Response of Firms to New Techniques,* Quarterly Journal of Economics, Vol. LXXVII, No. 2 (May, 1963), pp. 290-311.

10. Royal Commission on Canada's Economic Prospects, *The Outlook for the Canadian Forest Industries,* Queen's Printer, Ottawa, March, 1957.

11. To a considerable degree, the long-run demand for the Canadian production is dependent on its cost relative to the cost of production in other countries. To the extent that the innovations described in this study reduce costs, they improve Canada's relative position in the world market for pulpwood and its products.

12. Royal Commission on Canada's Economic Prospects, *The Outlook for the Canadian Forest Industries,* Queen's Printer, Ottawa, March, 1957, Table 59, p. 140.

13. Ibid., p. 142.

14. The Gordon Commission estimate of pulpwood exports for 1980 is to be found on page 151 of this report. Values for 1970 and 1975 were obtained by semi-logarithmic interpolation between the actual 1954 figure and the 1980 forecast.

15. Lachance, Paul E., *The Gordon Commission Concerning the Canadian Pulp and Paper Industry Eight Years Later,* paper presented at the annual meeting of the Woodlands Section, Canadian Pulp and Paper Association, Montreal, March 17, 1964.

16. A new log-chip mill process, which forms lumber from logs by chipping rather than by sawing, has been developed jointly by Domtar and the Soderhamn machinery manufacturing firm of Sweden. The important cost-saving feature of this "cant maker" is that very little sawdust wastage is produced. With further refinements Domtar expects that the equipment will be used widely by sawmilling firms in Eastern Canada. Because saw logs in Eastern Canada are of smaller diameter than those in Western Canada the cant maker will result in greater proportional savings in the East than in the West.

17. Industry data separate pulpwood into "limit" (wood produced on company owned or leased limits) and "purchased" wood. In this section "purchased" and "non-limit" are used interchangeably.

18. Newfoundland is almost totally dependent on limit wood. The percentage of non-limit wood is significant in New Brunswick and is roughly 75 per cent in Prince Edward Island and Nova Scotia. The latter two provinces are not covered in this study.

19. To some degree this has already occurred. Pulpwood production and residue consumption in 1965 will again be above the Gordon Commission trend, and plans for two previously planned mills in British Columbia have been abandoned.

20. Failure is, of course, a relative matter. A highly successful innovation can cause the failure of another, less successful, innovation.

21. Like all prototype machines, the Arbomatik processor and Beloit tree harvester models used to date have been subject to frequent breakdowns which greatly reduce their availability for processing operations.

22. An operating hour includes machine time and paid idle time. Machine time is time during which the machine is actually running. This time includes productive time, i.e., time during which machine is performing its normal function and unproductive time, i.e., time spent by machine on a function other than the normal one — for example, time taken for travelling between camp and work site. Paid idle time is the machine idle time during which direct labour continues to receive a wage. This time includes necessary idle time, that is, idle time during the performance of a productive phase of the working cycle (such as machine idle time during loading) and operating delayed time, that is, time which includes short delays occurring during the normal course of the operations (such as minor machine breakdowns, rest periods, etc.). For the purpose of estimating machine availability, this time can be further divided into mechanical delayed time and non-mechanical delayed time.

23. These companies are Domtar Limited, Montreal; Great Lakes Paper Company Limited, Fort William, Ontario; KVP Company Limited, Espanola, Ontario; and Marathon Corporation of Canada Limited, Marathon, Ontario.

24. The Marathon Corporation of Canada Limited built the sixth harvester.

25. It moves very short distances to pick up trees at the landing area and must be moved occasionally from one landing to another.

26. See, for instance, Bennett, W. D., *Logging Atlas of Canada,* Pulp and Paper Research Institute of Canada, 1958; Canada Department of Mines and Technical Surveys, Geographical Branch, *Atlas of Canada,* Queen's Printer, 1957; Canada Department of Northern Affairs and National Resources, Forestry Branch, Bulletin 123, *Forest Regions of Canada,* Queen's Printer, 1959.

27. In addition, "ultimate" is a word which is more convenient than precise. In the long run there may be shifts in cutting areas with a consequent shift in the local environment being cut. Changes of this kind and changes in the characteristics of the equipment itself can alter the "ultimate" extent of diffusion. Any particular "ultimate" extent may never be reached if other, more efficient, equipment takes the place of that under discussion.

    Note also that the diffusion levels in this section pertain to limit production only. Since non-limit diffusion of the new logging methods is expected to be negligible in the period under discussion, the diffusion levels for total production (limit plus non-limit) will be significantly lower than for limit production.

28. As Professor Seheult has noted (see Seheult, L. R., *The Rate of Mechanization in Woods Operations in the Atlantic Provinces and the Need for Skilled Manpower,* paper presented at CPPA Pulpwood Production and Manpower Conference, Toronto, November 16-17, 1965) it seems reasonable to expect development of a reconditioned skidder market in the near future and consequent increased skidder use on woodlot operations.

29. The feller-skidder cuts the tree at the stump and loads the full tree, with branches attached, onto itself. This machine eliminates the need for a pulpwood cutter. The self-loading skidder, with an overhead reaching arm, picks up full trees already felled by a pulpwood cutter. Both machines, having accumulated a full load, will proceed to the landing area where the trees are unloaded and are ready for the Arbomatik processor to process.

30. The grapple-skidder will be able to pick up pre-bunched tree lengths without a man on the ground as compared to the now conventional skidder in which the operator must descend from the machine and attach each tree length to the

skidder by means of a cable. The grapple-skidder reduces moderately the time per trip needed for the skidder to bring a load of tree lengths to a landing area.

31. The specific occupational estimates used here exclude most workers engaged in the transportation operation between the final landing and the mill. Truck drivers are, however, included and some reduction in this occupational group can be expected with the introduction of the pipeline between the final landing and the mill. If the pipeline were to be extended farther into the woods than the final landing, it would, of course, affect the diffusion and other occupational estimates made in this chapter.
32. Lachance, Roger A., *Full Tree Logging and the Sund Tree Processing System*, CPPA, Woodlands Section Index No. 2384 (B-1), paper presented at the 48th annual meeting of the Woodlands Section, CPPA, March, 1966.
33. The first test models of the harvester and Arbomatik began operation five years ago. The first Koehring processor test model was put in operation in Ontario in the fall of 1965 and is now being redesigned. The Sund Processing System was first introduced into Canada in late 1965.
34. Mansfield's studies showed no significant relationship between liquidity and purchase of new innovations. This negative finding is not, however, conclusive proof that no relationship exists. Should a surplus of kraft pulp, which is widely expected to develop, drive down prices and profits, it would obviously reduce liquidity. A serious liquidity squeeze might delay investment in the new machinery if it impaired access to the capital market. This factor is one of several which has suggested use of the same diffusion levels for both growth rates.
35. The odd size of the unit used for this purpose (77,400 cunits) is the result of a number of factors employed in the estimating procedure. The final results could be rebased on a more "usual" unit such as 100,000 cunits, but this would require considerable recomputation and would produce no change in the final results.
36. Recall, however, that estimates of truck drivers are those which are most likely to be seriously reduced should chip pipelines constitute a major transportation medium by 1975.
37. In a short-wood system the cutter fells, limbs, tops, bucks (and possibly barks) and piles short wood. In the tree-length system, he fells, limbs and tops tree lengths. There is variation within the short-wood system as to the length of the bolts and thus as to the percentage of time needed to fell the tree.
38. As noted previously, three-shift operations of Arbomatik processors would reduce the number of machines without altering the number of operators required.
39. If further improvements in the Arbomatik should permit a one-man operation, the number of operators would, obviously, be reduced by one-half — provided that the reduction in machine staff did not cause any decline in hourly output.
40. In 1970 and 1975, the Eastern Canadian company limit production was divided, for each growth rate output forecast, into three groups — Arbomatik production, harvester production, and production by conventional means. Each of these production figures was divided by the modular unit of 77,400 cunits and the resulting factor multiplied by the corresponding modular occupational distribution. The occupational distributions were then summed for the three groups for each year and the result placed in Tables 17 and 18.

Chapter V

IMPLICATIONS AND RATES OF CHANGE

Large numbers of men will be needed in several of the various logging industry occupations. The main question for those concerned with the training problem that is posed by these needs is to decide whether it will be more efficient to retrain persons currently working in declining industry occupations, to train persons currently employed in other industries, or to train those who will be entering the Canadian labour force for the first time. This sort of question is, it must be emphasized, one which cannot be answered by a study of this sort. It poses a very distinct set of problems which can be dealt with only by experimentation and comparison of results. Our concern here is to deal with some of the background considerations affecting the choice between the different sources of supply. This "choice" may prove to be more potential than real. Should a general labour shortage situation develop, it may prove to be necessary to train anyone who is willing to learn.

The other side of the coin presents problems as well. The estimates in Chapter IV show an overall decline in the labour force needed in pulpwood logging regardless of which demand forecast is used. Thus, a significant number of persons will have to move to a different industry, occupation, and, perhaps, region in order to maintain or increase their earnings. Some of those who will depart from the industry will be persons who possess alternative skills in demand in other parts of the economy; some will be persons whose skills are of little value elsewhere.

Nature of Present Woods Labour Force

From both points of view, it is important to know as much as possible about the characteristics of the present woods labour force. Unfortunately, nearly all the comprehensive data available are derived from the decennial Census of Canada. Since the census is carried out in June, a month of low logging employment in Eastern Canada, the material is only imperfectly representative of the total numbers and characteristics involved. The 1961 census provided data on "loggers and other related occupations"[1] who accounted for about three-quarters of the forest labour force at that time. For convenience, this group will be referred to simply as loggers.

Table 19. Per Cent of Male Labour Force, 15 Years of Age and Over with an Elementary Education or Less, Selected Occupational Groups and Provinces, 1961

Occupation	Ontario	Quebec	New Brunswick	Newfoundland
	(per cent)			
Loggers and related workers	80	87	87	79
Farmers and farm workers	68	85	79	71
Labourers	66	77	79	74
Miners, quarrymen and related workers	63	73	78	71
Craftsmen, production, and related workers	51	62	65	61
All occupations	42	52	57	54

SOURCE: Calculated from 1961 Census of Canada, Volume III, Part I, Bulletins 94-510 and 94-511, Table 17.

Because of the nature of the work involved, the forest labour force is almost totally male. These males, however, differ markedly from the general male labour force in Eastern Canada in a number of important ways.

Perhaps the most striking difference is in levels of education. Of all the various major census groups, loggers have by far the lowest levels of formal education. As Table 19 shows, between 79 per cent and 87 per cent of all loggers in the four provinces dealt with in this report have not progressed beyond elementary school.[2] As the table also shows, loggers have by far the lowest average educational attainments of all major occupational groups. Even farmers and unskilled labourers tend to have higher levels of education. Loggers are much less educated than the relatively highly paid craftsmen, production, and process workers.

These low educational levels are even more striking when account is taken of the fact that loggers are a relatively young group. In general, younger members of the labour force have higher levels of education than do older workers because of the long-run trend towards spending more years in school. The tendency of the logging labour force to be of a younger age than the general male labour force has persisted for many years at least partly because of the high level of muscular activity involved. The median age of loggers was about five years below that of the general male labour force in 1961 (see Table 20).

Table 20. Median Age of Logging and Total Male Labour Force, Eastern Canada and Provinces, 1961

	Ontario	Quebec	New Brunswick	Newfoundland	Eastern Canada
Logging	36.2	30.4	33.1	32.0	32.6
Total	38.1	36.5	37.9	36.1	37.4

SOURCE: Calculated from 1961 Census of Canada, Volume III, Part I, Bulletins 94-510 and 94-511, Table 17.

Loggers, as a group, also differ markedly from the general male labour force with respect to ethnic origin.[3] In Eastern Canada as a whole, some 70 per cent of all loggers are of French origin and about 20 per cent of British origin. There is considerable interprovincial variation in ethnic origin (see Table 21). As is true of the general labour force, nearly all Newfoundland loggers are of British origin. In the remaining provinces, however, the proportion of French origin is much higher than comparable figures for the male labour force in general. Only in Ontario is the proportion of non-English, non-French origin higher than would be expected considering the provincial population mix. Of the 44 per cent of Ontario loggers of "other" ethnic origin, two-thirds are themselves immigrants. The relevance of ethnic origin data to training questions is not clear. Data on language spoken are valuable in determining the nature of training courses, etc., but the degree of relationship between ethnic origin and languages spoken is unknown.

Table 21. Ethnic Origin of Logging Male Labour Force, Eastern Canada and Provinces, 1961

Province	British Isles	French	Other	Total
	(per cent)			
Ontario	21	35	44	100
Quebec	2	96	2	100
New Brunswick	35	62	3	100
Newfoundland	94	5	1	100
Eastern Canada	20	70	10	100

SOURCE: 1961 Census of Canada, Volume III, Part I, Bulletin 3.1-15, Table 22.

Data on mobility by occupation are not as complete as might be wished but are clearly adequate to demonstrate that persons employed in forest operations have a high degree of industrial mobility; that loggers have a high degree of occupational mobility; and that there is a great amount of interfirm mobility on the part of those employed in the industry. Census data on geographic mobility are not yet available but, in view of the high mobility rates shown in other dimensions, can be presumed to be high.

Data on occupational, interfirm, and interindustry mobility are available from Unemployment Insurance Commission records. A 10 per cent sample of the U.I.C. records for 1959-60 showed that 25 per cent of the forest labour force shifted to employment in some other industry during that period and that a number of persons equal to 24 per cent of the forest labour force entered the industry from other work areas.[4] The entry and exit rates for all industries average only 12 per cent during the same period. A similar picture is evident with respect to occupational mobility.[5] From 1956-57 to 1959-60, the annual average rates of entry and exit for loggers were 32 per cent and 41 per cent, respectively. For all occupational groups, the rate was 29.5 per cent. Of the 35 per cent of all loggers who left the occupation in 1959-60, slightly over one-half became labourers.

Turnover rates for Eastern Canadian pulpwood logging have already been presented in Chapter II. As is noted there, gross turnover in Eastern Canadian limit pulpwood logging is of the order of 10 per cent per week. In large part, this is related to the high degree of seasonality in this industry, but a considerable portion of this turnover would exist even in the absence of seasonality. Comparison of hiring and separation rates for forestry with other Canadian industries shows that both rates are more than twice as high in the forest industry as in any other. Even the "quits to be replaced" series, which probably understates the total, shows that on the average about 2 to 3 per cent of the Eastern Canadian pulpwood logging work force leaves the job each week despite a need for their labour.[6]

The high level of occupational mobility in logging creates the possibility of the development of a somewhat paradoxical situation. Temporary shortages may occur even in those occupations which are declining if the annual outflow of workers exceeds the decline in the amount of labour needed.

It is evident, then, that the Eastern Canadian woods labour force is male, is somewhat younger than average, contains an unusually high percentage of unmarried persons, is disproportionately of French origin, has an exceptionally low level of formal education, and has exceptionally high rates of interfirm, interindustry, and interoccupational mobility.

Table 22. A Model of Numbers of Persons to be Trained to Meet the Needs for a New Occupation Over a Five-Year Period

Year	(1) Have Beginning of Year	(2) Need	(3) Train	(4) Have During Year	(5) Quits at Year End	(6) Stay	(7) Quit Stock	(8) Quits Return	(9) Quits do not Return
1966......	0	200	200	200	60	140	60	0	60
1967......	140	400	260	400	120	280	180	18	162
1968......	298	600	302	600	180	420	342	49	293
1969......	469	800	331	800	240	560	533	88	445
1970......	648	1,000	352	1,000	300	700	745	133	612
Total......			1,445						

The Timing of Future Training Needs

The timing and extent of training needs, as will be made clear, do not coincide with the timing or extent of the numbers of persons needed in the occupation being considered. Training needs depend on the rate of change of employment desired and on the proportion of those trained who make themselves available for employment in the industry. The relationship between training, employment, and turnover is most readily described by means of a simple accelerator model which can also be used roughly to determine the actual annual training needs.

The principles involved in such a model are illustrated in Table 22. In this didactic model it has been assumed that there will be a need for 200 people (Column 2) for some occupation in the beginning of 1966 and that this need will increase by equal increments of 200 in succeeding years up to 1970 when the total needed will be 1,000. It is further assumed that the training process is instantaneous. Hence, at the beginning of 1966, we have zero people (Column 1), we need 200 (Column 2) and 200 people are instantly trained (Column 3) and, consequently, we have 200 working throughout the year (Column 4). At year end it is assumed that 30 per cent of the trained employees will quit.[7] For 1966 this would mean that 60 quit (Column 5) and that the rest, 140, remain employed (Column 6). The accumulated quits or drop out stock will then be 60 (Column 7). An additional (unsubstantiated) assumption is made—that 30 per cent of the accumulated years' quits who had not returned by a certain year will return in that year. Since there were no quits prior to 1966, the number of returnees at the end of 1966 is zero (Column 8). The quits who do not return in 1966 then total 60 (Column 9).

At the beginning of 1967 we have on hand 140 who did not quit and, since our needs in 1967 total 400, 260 must be trained. At the beginning of 1968 we have the 280 who worked that year and did not quit, plus the 18 quits (30 per cent of 60) who return to the occupation. An important feature which this model brings out is that although only 1,000 workers are needed at the beginning of 1970, it will have been necessary to train 1,445.

An accelerator model of this general sort has been experimentally applied to the Arbomatik processor operator forecasts contained in the preceding chapter in order to derive rough estimates of annual training needs.[8] The main modification in application has been the assumption of unequal increments which correspond to the S shaped curve of innovation. The assumptions of a 30 per cent annual departure and 30 per cent return rate have been retained.

Given the assumptions, the model (Figure 28) indicates a peak training need in the neighbourhood of about 320 Arbomatik processor operators in 1971 and in 1972 with a gradual decline thereafter despite the continuing increase in employment of operators through to 1975. That is, the training peak comes well before peak employment levels are reached. Training needs between 1965 and 1968 are relatively small but show rapid percentage increases.

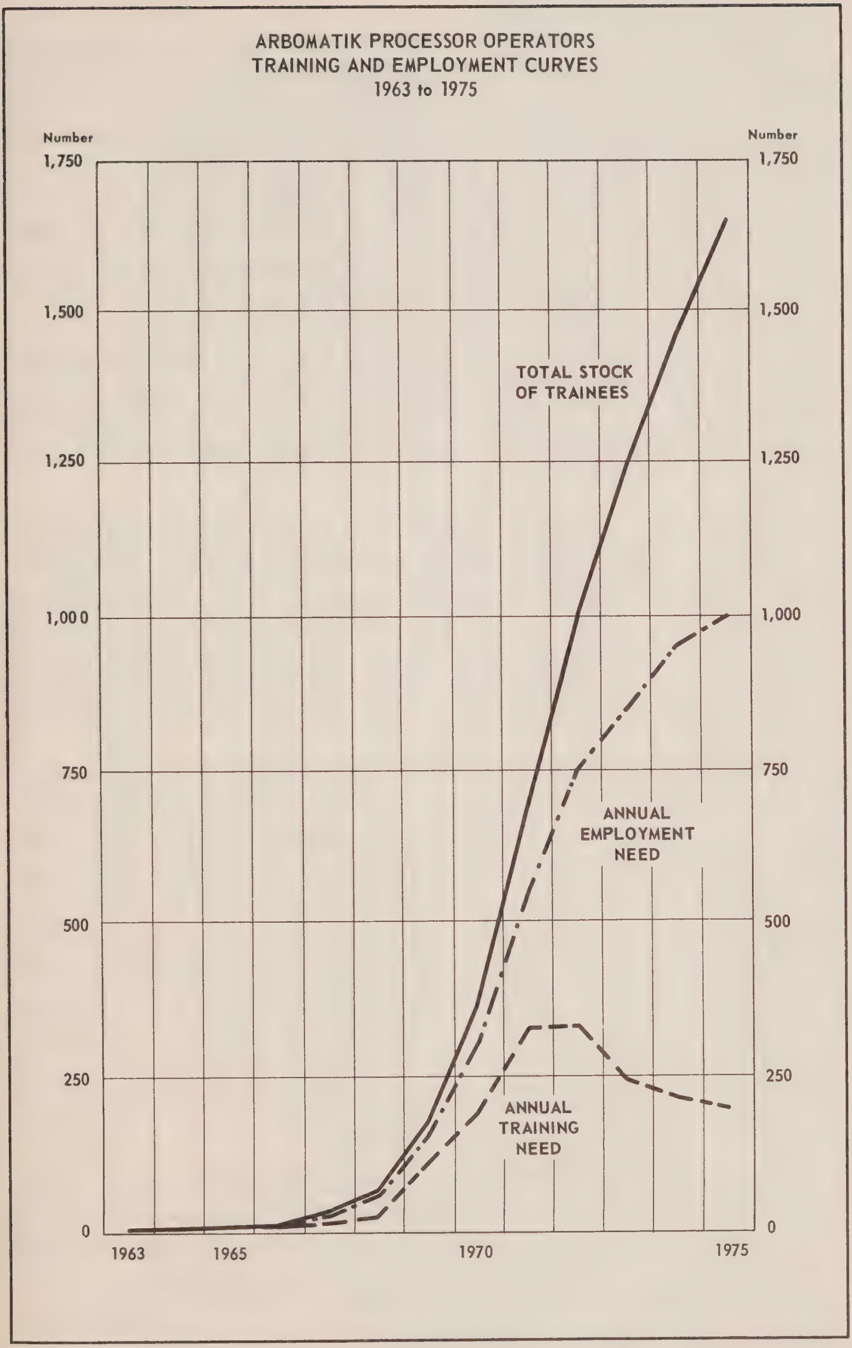
It should be pointed out that the model cannot reasonably be applied to the estimated needs for occupations in which there is already a basic stock of trained persons outside the industry. It would be possible to interpolate employment along the S curve, but the annual training need is dependent on the number of trained persons entering the industry from outside as well.

Displacements

Technological change has its own dynamism; it tends both to create the need for new and expanding occupations and cause a decline or disappearance of established occupations. Since nearly all technological change is labour saving, the decreases tend to outweigh the increases.[9] This is true with respect to the changes anticipated in pulpwood logging because of the magnitude of the labour saving that appears to be possible.

As Tables 17 and 18 of Chapter IV show, a considerable net displacement of labour is expected in this industry during the next ten years despite anticipated output increases. The largest single drop will occur among pulpwood cutters whose numbers will fall by almost 13,000[10] between 1964-65 and 1975. Other occupations such as teamsters, roadmen and swampers, labourers, cooks, cookees, and choreboys will decline, in total, by about 2,400 over the ten-year period.

Figure 28


ARBOMATIK PROCESSOR OPERATORS
TRAINING AND EMPLOYMENT CURVES
1963 to 1975
Number
1,750
1,500
1,250
1,000
750
500
250
0
Number
1,750
1,500
1,250
1,000
750
500
250
0
TOTAL STOCK OF TRAINEES
ANNUAL EMPLOYMENT NEED
ANNUAL TRAINING NEED
1963
1965
1970
1975

The approximate timing of the decline in these occupations, along with the actual declines since 1957 is shown in Figure 29.[11] The estimates are subject to much the same set of qualifications as the forecast of annual Arbomatik processor operators needs and should similarly be regarded as indicative rather than definitive. Perhaps the most significant feature of the chart is that, by the standards of the late 1950's, the net annual displacement will be relatively small. Even if events should proceed more rapidly than anticipated, it would be virtually impossible for the annual outflow in any one year to approach the previous peak of about 20,000 in 1957. The annual net displacement increases each year from 1966 to 1971, when the peak displacement of almost 3,500 is reached, and then declines through to 1975.[12] Only about one-third of the pulpwood cutters expected to leave by 1975 will have left by 1970, but some 75 per cent of the 2,400 other workers expected to leave during the ten-year period will have gone by 1970.

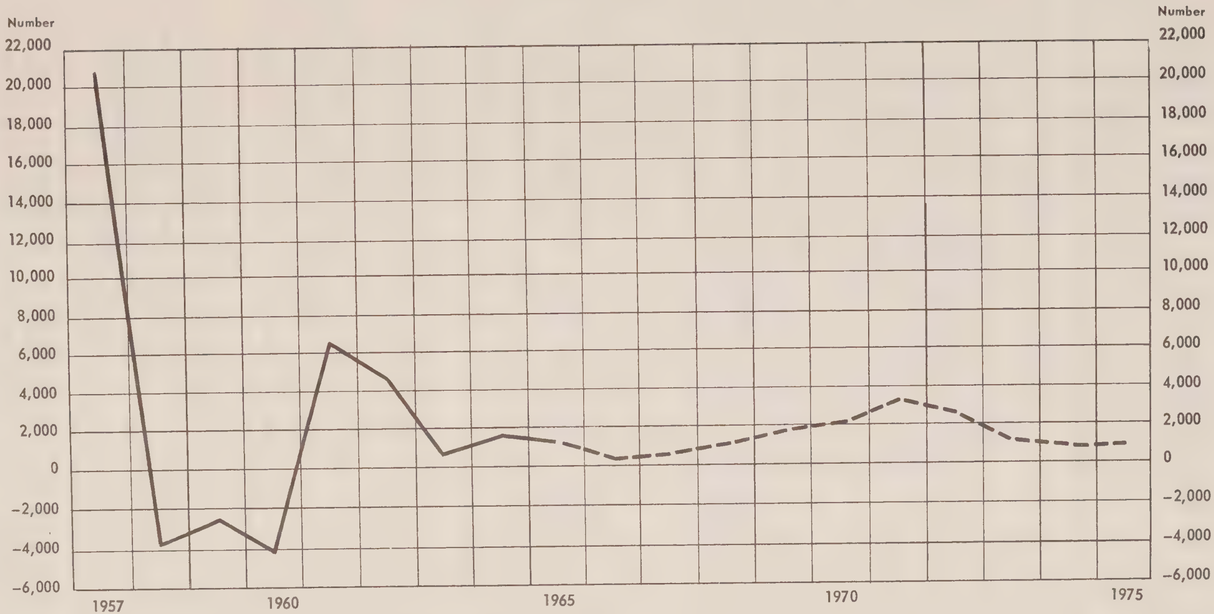
This substantial level of displacements over the period can be expected to add to pre-existing problems in a number of areas. The displacements of the past have had an adverse impact on growth in a number of areas and have contributed to the general Canadian regional unemployment problem. The continuing decline in employment in pulpwood logging will, in some areas, intensify these problems even though displacement will proceed at a slower pace than previously.

The displacement effects of technological change in logging are just as real as displacement in other industries, but tend to occur in a superficially more bearable fashion. The level of voluntary quits is so high in this industry that it would theoretically be possible to reduce the woods labour force to zero in the space of twelve months without laying off a single individual.[13] Thus, the reduction in the woods labour force may well consist almost totally of the so-called "silent firings"—some who quit will simply not be rehired or replaced.[14] Although departures of this sort are, obviously, much less noticeable than mass lay-offs they pose no less of a problem for the regional or national economy involved. The impact on regional incomes and employment trends is much the same regardless of the manner in which the departures take place.

The same is true of the need for retraining. Some of the present woods labour force will be absorbed more or less readily into the new woods occupations, but a portion will have to find employment in other industries and occupations. If the displacements occur in a period during which the general demand for unskilled labour is rising rapidly the immediate absorption problem will be of a low order. In the longer run, however, it is

Figure 29

ANNUAL NET DISPLACEMENT OF PULPWOOD CUTTERS AND OTHER OCCUPATIONS *
EASTERN CANADA, ACTUAL, 1957–1965
ESTIMATE, 1966–1975



*Includes teamsters, roadmen and swampers, labourers–production, cooks, cookees and choreboys, labourers–non–production and unspecified occupations.

Source: 1957–1965 data derived from Table A-1.

clear that outside opportunities for this type of labour will not expand to any significant degree and may actually decline.

Possible Implications for Smaller Woodlots

The lack of comprehensive statistical data on the ownership, output, and labour input of small and medium size woodlots has necessitated concentration on the manpower implications of the new technologies on company limit operations. As noted earlier, the share of production coming from woodlots is appreciable and it seems appropriate to explore briefly some of the possible implications of the new technologies for their future.[15] The future of the farm woodlot per se is probably best treated in the context of the future direction of agriculture and the agricultural labour force in Eastern Canada, but this is beyond the scope of this study.

Earlier, the assumption was made that Arbomatik processors and harvesters (or, for that matter, Koehring processors and Sund units) would not be used to any significant degree on other than large operations by 1975. The reasons for this assumption are the economies of year-round multi-shift operation attendant on investment in expensive equipment, the high cost of the equipment relative to the financing capacities of small economic units, the necessity for large annual volumes of wood available for processing, and the relatively clear cutting implied by the new methods.[16] These factors seem jointly to preclude the use of the new equipment on other than large tracts given the present forms of economic organization. The only major possibility of use of the machinery on smaller woodlots would seem, tentatively, to lie in a reorganization of this segment of the industry so massive as to constitute a fundamental change in its nature. The need for large units suggests that cutting in such areas will eventually be carried out by the consumers of the wood or by substantial firms—either privately owned or co-operatives—which operate on a year-round basis. If the latter is to be the shape of the future, it seems evident that there will be considerable difficulties to be overcome with regard to ownership and financing, as well as the general training problems to be faced by all users of the new equipment.

Based on considerations such as the above, it seems likely, as noted earlier, that woodlot operators will produce a smaller share of the Eastern Canadian pulpwood supply in the next ten years than they have in the past. Both the anticipated real cost shift in favour of limit production (because of the new equipment) and the declining supply of agricultural labour are expected to act to dampen expansion in this area and eventually, to reduce output. Technological change to date has not discriminated against the smaller units to nearly the degree which may be expected in the future. At

the moment, the only major intrinsic source of lower man-hour productivity is the disadvantage incurred by using horses or farm tractors rather than skidders.[17] In the longer run, however, the probable decline in the real cost of pulpwood from limit operations should act to hold down the real price paid to others, and thus to reduce real farm income and speed the exit from marginal farms in Eastern Canada.

REFERENCE NOTES

1. Loggers, forest rangers, logging foremen, etc.
2. In addition, over one-quarter of the total have less than a Grade 5 education. This group probably contains a large number of functional illiterates (persons whose formal education terminated at the Grade 4 level).
3. A person's ethnic origin is determined, in most cases, by the language spoken by that person when he emigrated to North America or by his paternal ancestor at the time of emigration.
4. *Canadian Statistical Review,* January, 1962, p. ii. That is, the forest labour force shrank by about 1 per cent during that period. These figures compare a person's industry of employment in May 1959 with his industry of employment in May 1960. They thus tend to understate the amount of movement, since a worker could shift from industry A to industry B and back to industry A within the twelve-month period. In such a case, the records would reveal no change in his industry over the period.
5. *Canadian Statistical Review,* February, 1962.
6. The destination of the departing workers is not known in general terms. The study based on U.I.C. records showed that only 24 per cent left the industry in 1959-60. Almost half of these (11 per cent of the total industry labour force) went into durable manufacturing while almost another one-sixth entered the construction industry. The industrial destination of departees will obviously depend, *inter alia,* on which industries are most rapidly expanding at the time of departure.
7. Note that this percentage corresponds roughly with the proportion which actually do shift from one U.I.C. occupation to another during an average year.
8. It is hardly necessary to point out that the results are subject to all of the qualifications to which the forecasts in Chapter IV are subject. In addition, they assume equal annual percentage output increases between 1964-65 and 1970 and between 1970 and 1975, and a specific set of values for the S curve. The S curve values for 1970 and 1975 are averages of the numbers given for the two output forecasts for each year. The results should reflect the general trend and level but are almost certain to be in error for any one year. As noted previously, this industry shows very large year-to-year variability in output.
9. Technological change is also frequently capital-saving. In addition, the labour saving may appear to be larger than it actually is if the change necessitates a higher level skill mix than was formerly used.
10. Average of the decreases for the two output forecasts.
11. Obtained from Table A-1.
12. It should be borne in mind that the numerical changes described here will not be the only ones. The functions performed by the remaining pulpwood cutters will frequently be less numerous than those currently performed by persons in this occupational category.

13. This is not, of course, strictly true. With weekly "quits to be replaced" (which includes an unknown but presumably low level of separations for cause) running at 2-4 per cent of the number of woods workers on the job each week (see Chapter II) this would indicate that substantially 100 per cent would leave within a twelve-month period or less. These figures represent, however, averages of higher and lower mobility groups. Probably the quit rate would decline rapidly as the more mobile left and were not rehired, leaving the low mobility groups to dominate the average.

14. Although, again, turnover is so high that it will almost certainly be necessary to rehire even for declining occupations. In this context, it should be noted that "shortages" can be experienced in declining ocupations if alternative employment opportunities and turnover are sufficiently high.

15. If Nova Scotia and Prince Edward Island were included in the definition of Eastern Canada, this share would rise slightly.

16. The latter poses a problem for the individual woodlot owner unless he cuts huge volumes of wood. A harvester, given the earlier assumption, is expected to process 15,300 cunits of wood per year in 1970. If an average density of 13 cunits per acre is assumed, the annual area cut by one harvester would be of the order of 1,200 acres.

17. Note also that wheeled skidders are still in the process of replacing horses and crawler tractors on limit operations. Note also that, although use of less efficient equipment lowers man-hour productivity, it does not necessarily raise total cost. There is little alternative employment for farm tractors or horses in the winter.

Appendix A

OCCUPATIONAL STRUCTURE STATISTICS

Description of the "Wage Rates, Salaries and Hours of Labour" Survey

Occupational wage rates and hours of labour statistics have been collected by the Canadian Department of Labour since 1900 and the results have been published annually since 1920. In the initial years, the data published were meager. In subsequent years, however, the scope of the statistics was gradually broadened and additional groups of industries were included. The survey now covers almost 30,000 establishments throughout Canada. This represents a substantially complete coverage of all establishments with 15 or more employees in the industries surveyed. Completed questionnaires are obtained from more than 80 per cent of all employers covered.

The survey is conducted by mailing a reporting form to the employers. The reporting schedule includes occupational descriptions (see section (c) of this appendix for a listing of occupational definitions) to help employers identify the specific jobs for which information is requested. In its present form the survey applies to fully qualified employees, excluding supervisory personnel and trainees or beginners. The most important criteria used in selecting the occupations to be included in the form are as follows: numerical importance in an industry or community; importance in the production processes of an industry; skill level; and capability of clear definition. The form consists of four parts. Part 1 is a general questionnaire designed to obtain information on the principal activities of the establishment, the number of office and non-office employees on the payroll, the standard work week for the majority of the establishment's employees, the methods of wage payment and the hiring and basic wage rates paid to labourers or unskilled employees. Part 2 asks for the number and salary of office workers, by occupation, on the establishment payroll. The number and hourly wage rates of those employed in maintenance trades and service occupations or as labourers are solicited in Part 3. The first three parts of the reporting form remain unchanged for all industries surveyed. However, Part 4 requests the number and wage rate or earnings per day of non-office occupations which are characteristic of the industry being surveyed.

Table A-1. Occupational Structure of the Pulpwood

Occupation	1956		1957		1958		1959	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total non-office employees	58,004	100.0	35,924	100.0	39,204	100.0	42,024	100.0
Production workers	43,861	75.6	27,268	75.9	30,239	77.1	34,026	80.9
Pulpwood cutter[2]	32,908	56.7	19,656	54.7	23,406	59.7	26,582	63.3
Truck driver[3]	1,616	2.8	1,401	3.9	1,141	2.9	1,275	3.0
Log-truck driver	1,616	2.8	1,401	3.9	1,141	2.9	1,275	3.0
Heavy truck driver	–	–	–	–	–	–	–	–
Light truck driver	–	–	–	–	–	–	–	–
Tractor driver	946	1.6	776	2.2	791	2.0	942	2.2
Teamster	4,099	7.1	2,391	6.7	2,603	6.6	2,511	6.0
Scaler	355	0.6	324	0.9	268	0.7	224	0.5
Loader	1,012	1.7	877	2.4	703	1.8	625	1.5
Roadman and swamper	2,925	5.0	1,843	5.1	1,327	3.4	1,867	4.4
Labourer, production[4]	–	–	–	–	–	–	–	–
Maintenance and service personnel	5,677	9.8	3,423	9.5	3,132	8.0	3,482	8.4
Cook, cookee and choreboy	3,676	6.3	2,146	6.0	1,892	4.9	2,003	4.8
Mechanic	506	0.9	375	1.0	361	0.9	445	1.1
Labourer, non-production[4]	–	–	–	–	–	–	–	–
Other maintenance and service personnel[5]	1,495	2.6	902	2.5	879	2.2	1,034	2.5
Unspecified occupations[6]	8,466	14.6	5,233	14.6	5,833	14.9	4,516	10.7

NOTES: [1]Includes Newfoundland, New Brunswick, Quebec and Ontario.

[2]Includes chopper and cutter.

[3]From 1956 to 1959 only "Log-truck driver" was requested. In 1961 "Log-truck driver" was reported as "Heavy truck driver".

[4]From 1956 to 1959 labourers were not requested. In 1960 "General Labourer" was asked for and is shown under non-production labourers. From 1961 to 1965, however, a breakdown by production and non-production was available and is shown as such in the table. Watchman and cleaner have been included with non-production labourers.

Pulpwood Logging Occupational Statistics—Description and Qualifications

The occupational structure data, as shown in Tables A-1 to A-4, were compiled from the returns to the above survey. The tables aggregate, by occupation, the returns from all establishments in Quebec, Ontario, Newfoundland and New Brunswick which reported that they were producing pulpwood as a primary product and which were operating in any of the years between 1956 and 1965.

"Total non-office employees" includes all non-office employees on the payroll on the pay day of the pay period reported by each establishment. The specified production occupations represent all production occupations

Logging Industry in Eastern Canada,[1] 1956-1965

1960		1961		1962		1963		1964		1965	
No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
46,642	100.0	38,789	100.0	34,414	100.0	34,098	100.0	32,760	100.0	31,323	100.0
31,964	68.7	26,723	68.9	23,580	68.5	23,827	69.9	23,607	72.1	22,341	71.3
24,234	52.0	21,459	55.3	18,429	53.6	18,400	54.0	17,680	54.0	16,785	53.6
1,720	3.7	624	1.6	874	2.5	1,226	3.6	1,514	4.6	1,337	4.3
1,561	3.4	–	–	679	1.9	989	2.9	1,258	3.8	981	3.1
95	0.2	541	1.4	102	0.3	159	0.5	188	0.6	326	1.1
64	0.1	83	0.2	93	0.3	78	0.2	68	0.2	30	0.1
924	2.0	1,075	2.8	1,310	3.8	1,448	4.2	1,521	4.7	1,596	5.1
2,741	5.9	1,116	2.9	794	2.3	577	1.7	723	2.2	567	1.8
361	0.8	422	1.1	508	1.5	575	1.7	579	1.8	589	1.9
785	1.7	670	1.7	625	1.8	560	1.6	563	1.7	459	1.4
1,199	2.6	910	2.3	739	2.1	743	2.2	691	2.1	696	2.2
–	–	447	1.2	301	0.9	298	0.9	322	1.0	312	1.0
4,703	10.1	3,540	9.1	3,381	9.8	2,874	8.4	3,147	9.6	2,875	9.2
1,860	4.0	1,687	4.3	1,422	4.1	1,418	4.2	1,462	4.4	1,314	4.2
396	0.8	358	0.9	359	1.0	367	1.1	450	1.4	480	1.5
1,531	3.3	815	2.1	903	2.7	551	1.6	746	2.3	654	2.1
916	2.0	680	1.8	697	2.0	538	1.5	489	1.5	427	1.4
9,975	21.4	8,526	22.0	7,453	21.7	7,397	21.7	6,006	18.3	6,107	19.5

[5]Includes blacksmith, carpenter, electrician, handyman, machinist, sawfiler and welder.

[6]From 1960 to 1965 this residual category includes probationary, temporary and part-time employees, learner, apprentice, beginner and trainee. In addition, for all years, the following are included: supervisory personnel, female employees, mechanical pulp harvester operator, skidder operator (some, however, are taken into account under "tractor driver"), power trucker and grader operator.

SOURCE: Canada Department of Labour, Economics and Research Branch, Returns to the *Wage Rates, Salaries and Hours of Labour* survey, 1956-1965.

Percentage figures may not add up to 100.0 because of rounding.

requested on the form and coded in the survey. Similarly, the maintenance and service occupations depict those maintenance and service occupations asked for and coded in the survey. The "unspecified" group is a residual category. It comprises "total non-office employees" minus the sum of the production, maintenance and service personnel. Some of the occupations represented in this category are footnoted in the tables.

The statistics were collected for one pay period in each year. From 1956 to 1959, the information to complete the return was requested for the last pay period before December 1. From 1960 to 1965, the information was asked for the last pay period preceding October 1. The fact that

Table A-2. Occupational Structure of the Pulpwood

Occupation	1956		1957		1958		1959	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total non-office employees	9,004	100.0	6,480	100.0	5,134	100.0	8,354	100.0
Production workers	7,266	80.6	4,847	74.8	3,626	70.6	6,485	77.6
Pulpwood cutter[2]	5,747	63.8	3,757	58.0	2,629	51.2	5,249	62.9
Truck driver[3]	396	4.4	370	5.7	287	5.6	220	2.6
Log-truck driver	396	4.4	370	5.7	287	5.6	220	2.6
Heavy truck driver	–	–	–	–	–	–	–	–
Light truck driver	–	–	–	–	–	–	–	–
Tractor driver	92	1.0	67	1.0	79	1.5	77	0.9
Teamster	472	5.2	285	4.4	300	5.9	736	8.8
Scaler	33	0.4	23	0.4	43	0.8	21	0.3
Loader	268	3.0	149	2.3	163	3.2	103	1.2
Roadman and swamper	258	2.8	196	3.0	125	2.4	79	0.9
Labourer, production[4]	–	–	–	–	–	–	–	–
Maintenance and service personnel	725	8.2	494	7.6	429	8.4	606	7.3
Cook, cookee and choreboy	475	5.4	286	4.4	268	5.3	389	4.7
Mechanic	41	0.5	10	0.2	26	0.5	29	0.3
Labourer, non-production[4]	–	–	–	–	–	–	–	–
Other maintenance and service personnel[5]	209	2.3	198	3.0	135	2.6	188	2.3
Unspecified occupations[6]	1,013	11.2	1,139	17.6	1,079	21.0	1,263	15.1

*Less than 0.05 per cent.
NOTES: [1]Includes Newfoundland and New Brunswick.
[2], [3], [4], [5], [6]. See notes to Table A-1.

these data depict single points in time restricts their meaning and use. The numbers of workers in the various production, maintenance and service occupations are reported for months of high seasonal employment (i.e., September to November). The information in the tables, therefore, is not to be construed as indicating an average of the occupational structure and employment levels for all the months of the logging year. The reader must also realize that cutting and hauling operations in logging are not necessarily started at the same time each year. Variation in the timing of these operations around the reporting dates will be reflected in the percentage distribution of the non-office occupations.

A significant change took place in 1960 when the type of form used in the survey was altered. The introduction of the new form is reflected in the occupational distribution in Table A-1 (as well as Tables A-2 to A-4 inclusive). The reader will note that the pulpwood cutter category in

Logging Industry in the Atlantic Provinces,[1] 1956-1965

1960		1961		1962		1963		1964		1965	
No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
10,851	100.0	8,821	100.0	7,017	100.0	7,897	100.0	8,391	100.0	8,411	100.0
6,721	62.0	6,240	70.7	4,759	67.8	5,989	75.8	5,955	71.0	5,944	70.7
5,624	51.8	5,034	57.0	3,646	52.0	4,940	62.6	4,352	51.9	4,442	52.8
495	4.6	131	1.5	228	3.2	291	3.7	536	6.4	492	5.9
484	4.6	–	–	206	2.9	220	2.8	446	5.3	303	3.6
1	–	113	1.3	10	0.1	53	0.7	59	0.7	173	2.1
10	–	18	0.2	12	0.2	18	0.2	31	0.4	16	0.2
138	1.3	158	1.8	232	3.3	232	2.9	306	3.6	269	3.2
180	1.7	300	3.4	163	2.3	67	0.8	258	3.1	222	2.6
24	0.2	68	0.8	110	1.6	140	1.8	147	1.8	140	1.7
121	1.1	357	4.0	296	4.2	264	3.3	281	3.3	283	3.4
139	1.3	187	2.1	81	1.2	51	0.6	72	0.9	96	1.1
–	–	5	0.1	3	*	4	0.1	3	*	–	–
748	6.9	977	11.1	762	10.9	713	9.0	690	8.2	743	8.8
387	3.6	409	4.6	242	3.4	310	3.9	354	4.2	331	3.9
35	0.3	41	0.5	25	0.4	28	0.4	43	0.5	73	0.9
155	1.4	375	4.3	418	6.0	319	4.0	225	2.7	276	3.3
171	1.6	152	1.7	77	1.1	56	0.7	68	0.8	63	0.7
3,382	31.1	1,604	18.2	1,496	21.3	1,195	15.1	1,746	20.8	1,724	20.5

SOURCE: Canada Department of Labour, Economics and Research Branch, Returns to the *Wage Rates, Salaries and Hours of Labour* survey, 1956-1965.
Percentage figures may not add up to 100.0 because of rounding.

Table A-1 declined from 63.0 per cent of the total non-office employees in 1959 to 51.1 per cent in 1960. At the same time the unspecified occupations category increased from 12.0 of the total non-office employees to 22.3 per cent.[1] The other occupations remained relatively stable.

Prior to 1960 the establishments completing the returns were asked to include in the specified groups all those workers whose duties accorded reasonably closely with the job descriptions on the forms. However, in 1960, the establishments were instructed to include the specified groups only *fully qualified employees* whose main duties correspond closely to the job descriptions on the forms. At the same time the establishments were asked to exclude from the specified groups, learners, apprentices, beginners, trainees, probationary, part-time and temporary employees. Although statistical verification is not possible, there is reason to believe that the exclusion of the probationary, part-time and temporary employees caused a

Table A-3. Occupational Structure of the Pulpwood

Occupation	1956		1957		1958		1959	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total non-office employees	37,149	100.0	23,516	100.0	26,933	100.0	26,810	100.0
Production workers	28,175	75.9	18,784	79.9	21,650	80.4	22,164	82.7
Pulpwood cutter[2]	19,867	53.5	13,259	56.4	17,028	63.2	16,767	62.5
Truck driver[3]	773	2.1	666	2.8	623	2.3	695	2.6
Log-truck driver	773	2.1	666	2.8	623	2.3	695	2.6
Heavy truck driver	–	–	–	–	–	–	–	–
Light truck driver	–	–	–	–	–	–	–	–
Tractor driver	510	1.4	410	1.7	479	1.8	579	2.2
Teamster	3,566	9.6	2,038	8.7	1,784	6.6	1,769	6.6
Scaler	217	0.6	208	0.9	141	0.5	125	0.5
Loader	648	1.7	611	2.6	473	1.8	460	1.7
Roadman and swamper	2,594	7.0	1,592	6.8	1,122	4.2	1,769	6.6
Labourer, production[4]	–	–	–	–	–	–	–	–
Maintenance and service personnel	3,578	9.6	2,073	8.8	2,132	7.9	2,313	8.6
Cook, cookee and choreboy	2,251	6.1	1,333	5.7	1,308	4.8	1,321	4.9
Mechanic	310	0.8	194	0.8	216	0.8	257	1.0
Labourer, non-production	–	–	–	–	–	–	–	–
Other maintenance and service personnel[5]	1,017	2.7	546	2.3	608	2.3	735	2.7
Unspecified occupations[6]	5,396	14.5	2,659	11.3	3,151	11.7	2,333	8.7

NOTES: [2], [3], [4], [5], [6]. See notes to Table A-1.
Percentage figures may not add up to 100.0 because of rounding.

reduction in the number of pulpwood cutters reported (even though total non-office employees increased), and that the excluded pulpwood cutters were still listed on the non-office employee payroll and were, therefore, included in the unspecified occupation category. This shift may have been accentuated by the coincident change in the reporting date from the last pay period preceding December 1 to the last pay period preceding October 1. It seems probable that a shift in the reporting date to an earlier point in the logging season would be a shift to a time when establishments are apt to have more probationary, part-time and temporary employees on their payroll. Only later in the season would probationary employees, in particular, become permanent.

Some other changes took place which, although they do not significantly affect the occupational structure data, should still be noted.

In 1961 the definition of a pulpwood cutter was revised to include persons using a power saw in addition to those using the bow-frame saw,

Logging Industry in the Province of Quebec, 1956-1965

1960		1961		1962		1963		1964		1965	
No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
27,791	100.0	22,445	100.0	19,885	100.0	18,763	100.0	17,296	100.0	16,294	100.0
19,724	71.0	15,472	68.9	13,583	68.3	12,754	68.0	13,224	76.5	11,949	73.3
13,952	50.2	12,312	54.9	10,508	52.8	9,388	50.0	9,706	56.1	8,791	53.9
903	3.3	249	1.1	315	1.6	577	3.1	661	3.7	537	3.3
807	3.0	–	–	209	1.0	475	2.5	549	3.1	442	2.7
63	0.2	196	0.9	53	0.3	71	0.4	89	0.5	87	0.5
33	0.1	53	0.2	53	0.3	31	0.2	23	0.1	8	0.1
504	1.8	639	2.8	736	3.7	818	4.4	887	5.1	947	5.8
2,471	8.9	815	3.6	630	3.2	509	2.7	464	2.7	345	2.1
249	0.9	263	1.2	297	1.5	335	1.8	338	2.0	342	2.1
593	2.1	280	1.2	302	1.5	258	1.4	274	1.6	128	0.8
1,052	3.8	711	3.2	652	3.3	664	3.5	618	3.6	600	3.7
–	–	203	0.9	143	0.7	205	1.1	276	1.6	259	1.6
3,094	11.1	1,892	8.4	1,963	9.9	1,519	8.1	1,761	10.2	1,503	9.2
1,186	4.3	1,015	4.5	917	4.6	881	4.7	893	5.2	791	4.9
172	0.6	150	0.7	154	0.8	141	0.8	154	0.8	164	1.0
1,138	4.0	337	1.5	410	2.1	145	0.8	390	2.3	298	1.8
598	2.2	390	1.7	482	2.4	352	1.8	324	1.9	250	1.5
4,973	17.9	5,081	22.6	4,339	21.8	4,490	23.9	2,311	13.4	2,842	17.5

SOURCE: Canada Department of Labour, Economics and Research Branch, Returns to the *Wage Rates, Salaries and Hours of Labour* survey, 1956-1965.

cross-cut saw, or axe, to cut down trees for pulpwood. However, the establishments had already included the power saw pulpwood cutters on their returns in previous years and this change of definition, consequently, caused no irregular variation in numbers of pulpwood cutters reported in 1961.

From 1956 to 1959 only "log-truck driver" was requested. In 1960 and from 1962 to 1965, in addition to "log-truck driver", "heavy truck driver" and "light truck driver" were requested. In 1961 "log-truck driver" was not requested on the form. Nevertheless, a number of establishments reported it under "heavy truck driver", which was requested. The absence of the "log-truck driver" category from the 1961 forms probably was responsible for the sharp and temporary dip in the reported total of truck drivers in that year, and a concomitant temporary increase in the "unspecified" category.

The occupation "labourer" was not requested from 1956 to 1959. In 1960 a new occupation category "general labourer" (unskilled male

Table A-4. Occupational Structure of the Pulpwood

Occupation	1956		1957		1958		1959	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total non-office employees	11,851	100.0	5,928	100.0	7,137	100.0	6,860	100.0
Production workers	8,420	71.0	3,637	61.4	4,963	69.5	5,377	78.4
Pulpwood cutter[2]	7,294	61.5	2,640	44.6	3,749	52.5	4,566	66.6
Truck driver[3]	447	3.8	365	6.2	231	3.2	360	5.2
Log-truck driver	447	3.8	365	6.2	231	3.2	360	5.2
Heavy truck driver	–	–	–	–	–	–	–	–
Light truck driver	–	–	–	–	–	–	–	–
Tractor driver	344	2.9	299	5.0	233	3.3	286	4.2
Teamster	61	0.5	68	1.1	519	7.3	6	0.1
Scaler	105	0.9	93	1.6	84	1.2	78	1.1
Loader	96	0.8	117	2.0	67	0.9	62	0.9
Roadman and swamper	73	0.6	55	0.9	80	1.1	19	0.3
Labourer, production[4]	–	–	–	–	–	–	–	–
Maintenance and service personnel	1,374	11.6	856	14.4	571	8.0	563	8.2
Cook, cookee and choreboy	950	8.0	527	8.8	316	4.4	293	4.3
Mechanic	155	1.3	171	2.9	119	1.7	159	2.3
Labourer, non-production[4]	–	–	–	–	–	–	–	–
Other maintenance and service personnel[5]	269	2.3	158	2.7	136	1.9	111	1.6
Unspecified occupations[6]	2,057	17.4	1,435	24.2	1,603	22.5	920	13.4

*Less than 0.05 per cent.

NOTES: [2], [3], [4], [5], [6]. See notes to Table A-1.

labourers engaged in production, maintenance and other non-production work) was added to the survey form. The 1960 "maintenance labourer" figure includes production labourers and is overstated by an estimated 300-400 persons. However, from 1961 to 1965 a breakdown between production and non-production labourers was available and appears as such in the tables.

The "Other Maintenance and Service Personnel" category includes blacksmiths, carpenters, handymen and sawfilers from 1956 to 1965. In addition, from 1960 to 1964, it includes electricians, machinists and welders.

REFERENCE NOTE

1. It should be noted that pulpwood cutter ratios also dropped significantly in 1957 and 1958 in Ontario and the Atlantic, with concomitant increases in the "Unspecified occupations" category. Such changes, however, were absent from the Quebec ratios. A diligent search of establishment returns and of other available information failed to provide an explanation for the Ontario and Atlantic changes.

Logging Industry in the Province of Ontario, 1956-1965

1960		1961		1962		1963		1964		1965	
No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
8,000	100.0	7,523	100.0	7,512	100.0	7,438	100.0	7,073	100.0	6,618	100.0
5,519	68.9	5,011	66.6	5,238	69.8	5,084	68.3	4,426	62.6	4,452	67.3
4,658	58.2	4,113	54.7	4,275	56.9	4,072	54.7	3,622	51.2	3,552	53.7
322	4.0	244	3.2	331	4.4	358	4.8	317	4.5	308	4.6
270	3.3	–	–	264	3.5	294	3.9	263	3.7	236	3.5
31	0.4	232	3.1	39	0.5	35	0.5	40	0.6	66	1.0
21	0.3	12	0.1	28	0.4	29	0.4	14	0.2	6	0.1
282	3.5	278	3.7	342	4.6	398	5.4	340	4.8	380	5.8
90	1.1	1	*	1	*	1	*	1	*	–	–
88	1.1	91	1.2	101	1.3	100	1.3	94	1.3	107	1.6
71	0.9	33	0.4	27	0.4	38	0.5	8	0.1	48	0.7
8	0.1	12	0.2	6	0.1	28	0.4	1	*	–	–
–	–	239	3.2	155	2.1	89	1.2	43	0.6	53	0.8
861	10.8	671	8.9	656	8.7	642	8.6	696	9.8	629	9.5
287	3.6	263	3.5	263	3.5	227	3.1	215	3.0	192	2.9
189	2.4	167	2.2	180	2.4	198	2.7	253	3.6	243	3.7
238	3.0	103	1.4	75	1.0	87	1.2	131	1.8	80	1.2
147	1.8	138	1.8	138	1.8	130	1.7	97	1.4	114	1.7
1,620	20.2	1,841	24.5	1,618	21.5	1,712	23.0	1,951	27.6	1,541	23.2

SOURCE: Canada Department of Labour, Economics and Research Branch, Returns to the *Wage Rates, Salaries and Hours of Labour* survey, 1956-1965.
Percentage figures may not add up to 100.0 because of rounding.

Definitions of Occupations Used in 1965 Survey

PULPWOOD CUTTER

Saws or chops down trees for pulpwood, using power saw, bow-frame or cross-cut saw, or axe; trims limbs from felled trees; stacks logs into regular piles for scaling and hauling. May peel the logs before stacking.

CHOPPER AND CUTTER

(Log Maker)

Cuts down trees with axe or cross-cut saw; trims limbs from felled trees; saws trees into logs of desired length.

LOG-TRUCK DRIVER

Drives a truck to haul logs from forest to a landing or log pond. May assist in loading and unloading logs. May fasten chain around logs on truck. May make minor mechanical repairs and keep truck in good working order.

HEAVY TRUCK DRIVER

Drives a heavy panel, stake or platform truck, usually of over three-ton capacity, a semi-trailer, or tractor-trailer to transport heavy or bulky merchandise, materials, and equipment. May service truck with gas and oil, keep vehicle clean, and make minor repairs or adjustments as required. May load or unload truck or assist others with this task. May keep record of work performed.

LIGHT TRUCK DRIVER

Drives a light panel, stake or platform truck, usually of three ton or under, to transport merchandise, materials and equipment. May service truck with gas and oil, keep vehicle clean, and make minor repairs or adjustments as required. May load or unload truck or assist others with this task. May keep record of work performed.

TRACTOR DRIVER

(Cat Driver; Tractor Operator)

Operates a gasoline-powered or diesel-powered crawler-tread tractor used for road building, ground skidding, power skidding, loading or hauling logs. May oil, grease and make adjustments and minor repairs to tractor. (Tractors may have added attachments for some of the operations such as road building, power skidding, and loading of logs.)

TEAMSTER

(One or two horses only)

Drives one or two horses to haul logs on sleighs, or to drag (snake) logs out of the woods along skidding path to landing or loading place; assists in loading or unloading sleighs. May haul wood or water for camp use. May assist in the grading or building of roads. May groom, feed, and water horses.

SCALER

(Exclude Assistants)

Determines and records the volume of timber in logs: measures the length and diameter of log with scaling stick or tape; records measurements; estimates probable waste due to defects in logs and reduces the appraisal of lumber content accordingly. May reject logs that contain an excess of unsound timber.

LOADER

(Hookman)

Assists in rolling logs upon a log deck, or in loading logs upon railroad cars, trucks or other vehicles: maneuvres log into position with peavey, and fastens chains, tongs or other devices about log for loading; or guides log with peavey as the log is pulled up skids and on to log deck. May unhook cable or other rigging, as log is guided into final position.

ROADMAN AND SWAMPER

(Road Cutter; Trail Cutter)

(Exclude bulldozer operator)

Works as one of a crew in building and maintaining logging roads, skidding trails, and landings: clears ground of obstruction such as trees, stumps, and underbrush; places logs or poles in swampy places in road; excavates earth where necessary to smooth the grade of road.

LABOURER — PRODUCTION DEPARTMENTS — MALE

(Exclude machine operator's helpers, maintenance tradesman's helpers, unskilled workers performing simple machine or assembly operations, and those performing specific processing operations.)

Performs various unskilled light or heavy manual duties in departments engaged directly in production, frequently moving from one duty to another: performs duties such as moving empty, partially filled and filled tote boxes or other containers to and from processing operations, removing waste products to disposal areas, cleaning machinery or equipment in production areas; uses simple tools and equipment in performing duties.

COOK (Male only)

Prepares, seasons and cooks all meats, fruits, vegetables and other foods: plans, prepares and cooks meals; mixes and bakes bread, biscuits and pastries. May estimate consumption and requisition food supplies. May wash dishes and clean kitchen. May prepare lunches for men working away from camp. May supervise one or more Cooks and Cookees.

COOKEE (Male only)

Performs routine duties about the cook house of a logging camp: cuts, peels or otherwise prepares vegetables; carries water, washes dishes, and scrubs floors; chops wood and kindles kitchen fires; watches cooking food to prevent burning. Works under supervision of Cook.

CHORE BOY
(Bull Cook)

Performs routine duties, that require little skill, about a logging camp: disposes of garbage and keeps camp area clean; sweeps and tidies sleeping quarters. May cut firewood and carry water to cook house.

MECHANIC
(Machine Repairman)

Maintains and repairs machinery and mechanical equipment: examines machinery to diagnose source of trouble; dismantles machine after locating defect; replaces defective part, obtaining replacement from stock, or having part made by machine shop, reassembles machine and makes operating adjustments.

LABOURER—NON-PRODUCTION MAINTENANCE AND SERVICES—MALE

(Exclude unskilled workers performing any steps in the processing of a product or service, also tradesman's helper regularly engaged in assisting maintenance tradesmen.)

Performs various unskilled light or heavy manual duties such as lifting, carrying, moving and stacking materials or equipment, hand-shovelling loose materials, collecting and disposing of refuse, digging and levelling roads and ditches; uses simple tools and equipment in performing duties.

Appendix B

SEASONAL ADJUSTMENT OF PULPWOOD LOGGING EMPLOYMENT

Tables B-1 to B-4 present a newly derived and previously unpublished series covering employment in pulpwood logging in Newfoundland, Nova Scotia, New Brunswick, Quebec, Ontario and the Prairies, from June, 1951 to May, 1965. The statistics are compiled from returns to the Canadian Pulp and Paper Association's weekly *Summary of Reports on the Labour Situation.* All pulp and paper companies belonging to the CPPA are included in the survey.

The labour report asks for the daily average number of non-staff personnel on operations for the end of the week surveyed. The numbers for each week are then summed and averaged to yield a monthly figure. The labour supply report requests once a month the number of staff personnel (presumably office employees) on the woods division working force. The staff figures are available only for east of the Rockies. Consequently, the provincial employment series below represent non-staff employment while the east of the Rockies series represents total employment.

The final seasonal components in Tables B-5 to B-8 were computed by the Census II method of seasonal adjustment through the courtesy of the Dominion Bureau of Statistics. The seasonal components show the factor by which each of the raw monthly figures must be divided in order to produce seasonally adjusted data. Comparison of these final seasonal components over time shows shifts in the pattern of seasonality.

The tables containing the seasonally adjusted series also show a number of other useful measures:

- SCI — Average of monthly percentage changes in the seasonal, cyclical and irregular factors;
- I — Average of monthly percentage changes in the irregular factor;
- C — Average of monthly percentage changes in the cyclical factor;
- S — Average of monthly percentage changes in the seasonal factor;

Table B-1. Total Pulpwood Logging Employment, East of the Rockies, Original CPPA Series, June 1951-May 1965

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	(number)											
1951.....	–	–	–	–	–	40,464	39,590	38,114	52,687	71,324	80,338	76,638
1952.....	76,858	71,253	38,372	17,882	33,453	33,912	29,231	31,726	47,314	59,461	62,809	50,003
1953.....	52,040	41,658	22,109	19,425	29,515	30,982	27,957	29,321	45,386	61,548	60,264	43,462
1954.....	45,573	35,829	17,121	12,385	27,361	32,463	31,605	31,879	48,467	61,399	64,911	53,647
1955.....	48,042	37,228	23,486	14,351	29,918	35,542	31,086	33,601	50,312	62,656	64,896	58,100
1956.....	54,542	44,134	26,203	18,045	64,982	40,974	40,360	37,631	49,859	59,727	59,564	55,286
1957.....	53,117	44,706	22,345	13,165	33,359	42,958	39,051	32,831	42,261	46,977	36,843	31,144
1958.....	32,826	26,879	15,564	11,047	25,166	33,962	30,045	27,383	33,895	40,114	39,406	36,925
1959.....	30,070	20,182	11,196	8,862	19,951	32,999	32,741	29,946	38,721	46,157	43,941	38,289
1960.....	32,398	26,772	13,392	7,928	20,602	34,974	38,393	36,541	42,591	48,617	42,869	34,207
1961.....	30,481	20,340	8,752	7,177	19,305	32,081	32,167	6,402	35,964	42,527	38,839	31,249
1962.....	30,680	22,611	12,182	8,491	17,886	30,745	31,399	31,922	33,864	36,039	33,820	30,333
1963.....	25,378	17,254	10,208	7,390	15,590	27,488	30,785	31,633	34,135	36,755	34,805	29,479
1964.....	26,972	21,499	13,972	9,444	20,449	32,991	35,530	34,817	34,914	35,713	33,444	29,787
1965.....	26,516	22,782	14,195	12,343	18,752	–	–	–	–	–	–	–

SOURCE: Calculated from CPPA weekly *Summary of Reports on the Labour Situation*, June 2 1951 - May 29 1965.

Table B-2. Non-Staff Pulpwood Logging Employment, Ontario and Prairies, Original CPPA Series, June 1951-May 1965

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	(number)											
1951	–	–	–	–	–	9,077	10,909	9,150	10,982	13,827	16,320	16,825
1952	15,593	14,552	8,226	5,256	7,186	6,616	6,123	7,031	8,810	9,250	8,949	8,113
1953	9,414	8,677	4,693	3,565	5,692	7,038	7,127	8,264	10,495	11,739	11,350	9,569
1954	10,033	9,063	4,681	3,297	5,067	7,115	7,380	8,460	10,558	11,216	10,657	9,502
1955	9,526	8,476	5,585	3,875	6,083	7,298	7,321	7,687	9,785	11,080	10,641	9,976
1956	10,216	9,632	6,376	5,100	7,326	8,462	8,803	8,845	10,126	10,936	10,920	10,566
1957	10,699	10,693	7,766	5,182	7,793	10,032	10,168	10,245	9,751	7,885	5,745	4,974
1958	7,056	7,249	4,309	2,769	5,448	7,194	7,348	7,229	6,940	6,635	6,927	6,553
1959	6,529	5,464	2,575	1,780	3,872	6,611	7,211	6,669	7,519	7,818	7,449	7,448
1960	6,160	5,933	2,923	2,476	4,616	6,939	7,820	8,356	7,797	7,873	6,932	6,410
1961	5,685	4,419	2,000	1,500	3,379	4,900	5,750	6,358	6,681	6,731	6,533	5,762
1962	6,008	5,717	3,737	2,204	3,758	5,781	6,659	7,005	6,980	6,883	6,580	6,064
1963	6,064	4,089	3,336	2,525	4,410	5,870	6,188	6,695	6,857	6,763	6,273	5,807
1964	6,059	5,828	4,249	2,853	4,079	5,835	6,383	6,658	6,608	6,579	6,282	6,545
1965	6,528	6,258	5,378	4,243	4,758	–	–	–	–	–	–	–

SOURCE: See Table B-1.

Table B-3. Non-Staff Pulpwood Logging Employment, Quebec Original CPPA Series, June 1951-May 1965

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	(number)											
1951	–	–	–	–	–	18,196	17,279	18,320	28,258	41,574	47,976	45,938
1952	45,636	41,346	18,854	5,799	17,271	16,423	13,496	15,548	27,305	36,938	39,598	30,447
1953	30,044	20,998	7,078	5,892	12,738	12,958	10,830	11,699	23,302	36,530	36,209	25,660
1954	25,356	16,255	5,093	2,882	11,708	13,653	12,594	13,653	25,517	36,332	40,689	33,943
1955	28,641	16,666	4,754	3,201	13,227	16,286	13,554	15,565	27,427	36,410	38,804	35,493
1956	32,302	21,512	10,123	7,160	16,889	18,410	17,729	16,686	25,398	33,170	35,347	34,431
1957	30,010	22,491	7,330	2,821	15,475	19,449	16,396	12,677	21,663	28,483	23,184	19,726
1958	19,318	12,906	3,791	2,117	10,676	15,830	13,093	11,629	18,444	24,961	24,226	22,126
1959	16,793	9,272	4,472	2,934	10,175	16,640	15,708	14,816	21,279	26,581	26,744	24,047
1960	19,935	12,749	4,899	1,701	8,800	16,119	18,044	18,300	22,675	28,030	25,658	20,031
1961	17,185	8,998	2,130	1,470	10,562	18,482	18,315	16,820	20,112	21,831	19,235	16,893
1962	15,354	8,950	2,478	1,650	8,399	15,102	15,728	16,692	18,619	19,938	18,535	16,847
1963	12,523	6,677	1,828	845	6,769	13,583	15,986	16,179	18,296	19,617	18,879	15,500
1964	12,558	8,018	3,310	1,957	9,697	17,283	18,380	17,647	18,770	18,877	17,609	15,164
1965	12,802	9,486	4,019	1,936	8,664	–	–	–	–	–	–	–

SOURCE: See Table B-1.

Table B-4. Non-Staff Pulpwood Logging Employment, Atlantic,* Original CPPA Series, June 1951-May 1965

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						(number)						
1951	–	–	–	–	–	6,973	6,094	5,757	7,504	9,321	9,395	7,676
1952	9,304	9,556	6,220	2,364	4,160	6,429	5,385	4,457	4,858	8,413	8,782	6,263
1953	7,019	7,034	5,373	5,213	6,540	6,297	5,446	4,277	6,295	8,275	7,838	4,073
1954	6,387	6,896	3,960	3,041	6,206	7,466	5,741	5,251	8,028	9,056	8,546	5,503
1955	5,568	8,106	6,191	3,486	6,368	7,453	5,805	5,764	8,014	10,114	11,183	7,550
1956	6,506	8,344	5,638	1,934	6,161	8,787	8,588	7,309	10,072	10,547	8,099	5,167
1957	7,509	6,749	3,377	2,703	5,718	8,727	7,235	5,210	6,217	5,768	4,250	2,779
1958	2,942	3,113	4,184	2,632	4,663	6,745	6,093	4,506	4,388	4,597	3,870	4,024
1959	4,051	2,556	2,226	1,349	2,047	5,939	6,090	4,150	5,927	7,095	5,725	3,350
1960	3,100	4,687	1,677	865	3,516	7,501	7,674	5,726	7,509	8,144	5,994	3,695
1961	3,923	3,781	1,598	660	1,949	4,161	3,932	2,879	5,426	9,934	8,467	4,667
1962	5,715	4,873	2,228	1,384	2,595	5,496	4,882	3,266	4,157	5,187	4,271	3,424
1963	3,245	2,886	1,305	811	1,486	4,436	5,051	4,616	4,904	5,712	5,564	4,503
1964	4,623	3,982	2,570	1,880	2,780	5,373	6,286	5,789	5,549	5,881	5,272	3,989
1965	3,617	3,086	2,003	1,723	1,284	–	–	–	–	–	–	–

*Includes Newfoundland, Nova Scotia and New Brunswick.

SOURCE: See Table B-1.

Table B-5. Total Pulpwood Logging Employment, East of the Rockies, Final Seasonal Components, June 1951-May 1966

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1951.....	–	–	–	–	–	.7660	.7332	.7757	1.1571	1.5241	1.6174	1.3409
1952.....	1.3235	1.1119	.5478	.3567	.7056	.7838	.7419	.7816	1.1714	1.5362	1.6135	1.3260
1953.....	1.3003	1.0715	.5431	.3571	.7326	.8134	.7574	.7941	1.1883	1.5360	1.5953	1.3108
1954.....	1.2701	1.0262	.5392	.3558	.7644	.8582	.7892	.8125	1.2033	1.5306	1.5577	1.2928
1955.....	1.2367	.9885	.5310	.3507	.7963	.9146	.8358	.8373	1.2099	1.5073	1.5080	1.2838
1956.....	1.2003	.9461	.5201	.3451	.8089	.9788	.8976	.8699	1.2149	1.4846	1.4568	1.2769
1957.....	1.1622	.9121	.5016	.3334	.8051	1.0333	.9639	.9132	1.2229	1.4679	1.4182	1.2663
1958.....	1.1292	.8752	.4724	.3194	.7824	1.0809	1.0370	.9456	1.2456	1.4753	1.4001	1.2370
1959.....	1.1007	.8422	.4425	.3065	.7511	1.1128	1.1009	.9860	1.2682	1.4787	1.3948	1.2157
1960.....	1.0790	.8040	.4196	.2990	.7185	1.1356	1.1551	1.0293	1.2959	1.4812	1.3931	1.1897
1961.....	1.0580	.7794	.4146	.2966	.6986	1.1431	1.1928	1.0895	1.3123	1.4668	1.3792	1.1692
1962.....	1.0412	.7665	.4191	.3052	.6868	1.1494	1.2235	1.1373	1.3237	1.4470	1.3575	1.1431
1963.....	1.0221	.7669	.4381	.3221	.6771	1.1504	1.2385	1.1906	1.3202	1.4147	1.3283	1.1312
1964.....	1.0049	.7664	.4564	.3433	.6691	1.1527	1.2490	1.2293	1.3153	1.3900	1.3049	1.1189
1965.....	.9870	.7733	.4746	.3578	.6640	1.1539	1.2543	1.2487	1.3129	1.3777	1.2932	1.1128
1966.....	.9781	.7768	.4837	.3651	.6615	–	–	–	–	–	–	–

Average absolute monthly amplitudes:

SCI	*I*	*C*	*S*	*CI*
32.54	8.29	2.66	29.14	9.19

MCD = 4

Table B-6. Non-Staff Pulpwood Logging Employment, Ontario and Prairies, Final Seasonal Components, June 1951-May 1966

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1951	–	–	–	–	–	.7699	.8752	.8787	1.1816	1.2785	1.3382	1.2629
1952	1.2982	1.2027	.6769	.4755	.7183	.7993	.8775	.9032	1.1914	1.2945	1.3270	1.2355
1953	1.2753	1.1784	.6731	.4782	.7235	.8360	.8889	.9370	1.2018	1.3065	1.3035	1.1979
1954	1.2415	1.1456	.6766	.4845	.7350	.8807	.9155	.9783	1.2100	1.3024	1.2708	1.1591
1955	1.2045	1.1199	.6814	.4870	.7496	.9283	.9578	1.0244	1.2095	1.2792	1.2317	1.1266
1956	1.1717	1.0923	.6754	.4771	.7618	.9759	1.0170	1.0613	1.2045	1.2486	1.1994	1.1152
1957	1.1467	1.0687	.6513	.4596	.7672	1.0130	1.0765	1.1019	1.1981	1.2259	1.1763	1.1149
1958	1.1306	1.0397	.6086	.4308	.7627	1.0420	1.1293	1.1475	1.2077	1.2209	1.1671	1.1129
1959	1.1189	1.0173	.5673	.4007	.7473	1.0584	1.1668	1.1912	1.2184	1.2268	1.1710	1.1156
1960	1.1129	.9883	.5410	.3819	.7369	1.0658	1.1862	1.2182	1.2364	1.2418	1.1783	1.1123
1961	1.1037	.9699	.5490	.3888	.7304	1.0620	1.1870	1.2343	1.2426	1.2475	1.1774	1.1076
1962	1.0935	.9564	.5859	.4180	.7280	1.0570	1.1765	1.2403	1.2488	1.2417	1.1646	1.0894
1963	1.0800	.9607	.6451	.4570	.7209	1.0521	1.1631	1.2363	1.2389	1.2233	1.1447	1.0784
1964	1.0725	.9640	.6952	.4963	.7159	1.0523	1.1520	1.2224	1.2279	1.2069	1.1249	1.0704
1965	1.0618	.9709	.7326	.5267	.7063	1.0524	1.1465	1.2155	1.2224	1.1987	1.1150	1.0664
1966	1.0565	.9744	.7513	.5419	.7015	–	–	–	–	–	–	–

Average absolute monthly amplitudes:

SCI	*I*	*C*	*S*	*CI*
19.57	5.60	2.89	17.81	6.65

MCD = 3

Table B-7. Non-Staff Pulpwood Logging Employment, Quebec, Final Seasonal Components, June 1951-May 1966

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1951.....	–	–	–	–	–	.6453	.5978	.6870	1.2511	1.7209	1.8768	1.5169
1952.....	1.4207	1.0696	.3515	.2111	.6134	.6648	.6024	.6829	1.2516	1.7287	1.8835	1.5196
1953.....	1.4173	1.0186	.3372	.2081	.6253	.6983	.6191	.6900	1.2533	1.7278	1.8747	1.5302
1954.....	1.4086	.9682	.3241	.2045	.6449	.7510	.6544	.7007	1.2588	1.7277	1.8344	1.5224
1955.....	1.3874	.9283	.3146	.1941	.6644	.8182	.7059	.7184	1.2593	1.7169	1.7756	1.5166
1956.....	1.3554	.8963	.3048	.1834	.6814	.8911	.7713	.7488	1.2682	1.7038	1.7030	1.4923
1957.....	1.3042	.8658	.3010	.1709	.6765	.9515	.8462	.8023	1.2802	1.6893	1.6471	1.4647
1958.....	1.2541	.8320	.2882	.1572	.6705	1.0065	.9279	.8676	1.3038	1.6821	1.5979	1.4118
1959.....	1.2096	.7870	.2661	.1416	.6565	1.0493	1.0067	.9519	1.3275	1.6621	1.5649	1.3766
1960.....	1.1710	.7343	.2365	.1268	.6480	1.0907	1.0868	1.0465	1.3604	1.6326	1.5312	1.3350
1961.....	1.1277	.6805	.2172	.1187	.6367	1.1231	1.1633	1.1458	1.3914	1.5961	1.5000	1.2995
1962.....	1.0843	.6458	.2073	.1134	.6381	1.1612	1.2340	1.2211	1.4188	1.5631	1.4608	1.2520
1963.....	1.0402	.6277	.2097	.1142	.6392	1.1894	1.2830	1.2753	1.4366	1.5349	1.4313	1.2184
1964.....	.9967	.6200	.2206	.1193	.6388	1.2120	1.3191	1.3067	1.4490	1.5152	1.4142	1.1882
1965.....	.9589	.6180	.2377	.1259	.6349	1.2233	1.3372	1.3224	1.4552	1.5054	1.4057	1.1731
1966.....	.9400	.6170	.2463	.1292	.6330	–	–	–	–	–	–	–

Average absolute monthly amplitudes:

SCI	*I*	*C*	*S*	*CI*
56.74	8.59	3.29	54.58	9.56

MCD = 4

Table B-8. Non-Staff Pulpwood Logging Employment, Atlantic,* Final Seasonal Components, June 1951-May 1966

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1951.....	–	–	–	–	–	1.0284	.8737	.7600	1.0121	1.3449	1.3562	.9758
1952.....	1.1794	1.2415	.8602	.4721	.8528	1.0374	.8736	.7652	1.0467	1.3641	1.3667	.9406
1953.....	1.1189	1.2176	.8354	.4678	.8810	1.0720	.8971	.7855	1.0920	1.3781	1.3558	.8989
1954.....	1.0520	1.1753	.7982	.4619	.9109	1.1236	.9458	.8213	1.1470	1.3871	1.3255	.8515
1955.....	.9852	1.1151	.7656	.4470	.9253	1.1969	1.0276	.8779	1.1957	1.3761	1.2606	.8271
1956.....	.9332	1.0239	.7312	.4353	.9161	1.2738	1.1268	.9333	1.2313	1.3684	1.2056	.8211
1957.....	.8871	.9536	.6931	.4006	.9787	1.3482	1.2363	.9832	1.2581	1.3758	1.1601	.8251
1958.....	.8770	.9018	.6297	.3650	.8276	1.4011	1.3128	1.0018	1.2753	1.4242	1.1640	.8195
1959.....	.8762	.8838	.5683	.3298	.7715	1.4193	1.3491	1.0056	1.2828	1.4792	1.1895	.8450
1960.....	.9034	.8874	.5133	.2996	.7007	1.4111	1.3509	1.0021	1.2773	1.5290	1.2470	.8784
1961.....	.9258	.9145	.4796	.2771	.6403	1.3698	1.3420	1.0230	1.2736	1.5453	1.2872	.9219
1962.....	.9661	.9292	.4626	.2840	.5800	1.3227	1.3295	1.0609	1.2640	1.5326	1.3149	.9537
1963.....	.9871	.9151	.4771	.3214	.5360	1.2663	1.3263	1.1167	1.2517	1.4870	1.3169	.9983
1964.....	1.0025	.8826	.5018	.3673	.4943	1.2265	1.3368	1.1726	1.2424	1.4376	1.3144	1.0211
1965.....	.9993	.8612	.5223	.4042	.4762	1.2066	1.3421	1.2006	1.2378	1.4129	1.3132	1.0325
1966.....	.9977	.8505	.5326	.4227	.4672	–	–	–	–	–	–	–

*Includes Newfoundland, Nova Scotia and New Brunswick.
Average absolute monthly amplitudes:

SCI	*I*	*C*	*S*	*CI*
35.30	12.40	4.44	31.23	13.62

MCD = 4

Table B-9. D^2, A Summary Measure of Trends Toward a Nine-Month Employment Year, East of the Rockies and Provinces, 1952-1965

	East of the Rockies	Ontario and Prairies	Quebec	Atlantic*
1952	.86	.34	1.82	.38
1953	.80	.27	1.77	.29
1954	.69	.20	1.63	.27
1955	.56	.12	1.43	.22
1956	.44	.07	1.20	.23
1957	.35	.04	.98	.31
1958	.32	.03	.81	.44
1959	.31	.04	.68	.50
1960	.33	.06	.60	.50
1961	.33	.07	.57	.50
1962	.32	.08	.57	.37
1963	.30	.07	.57	.29
1964	.29	.06	.58	.26
1965	.29	.06	.61	.26

NOTE: D^2 shows trend toward or away from reduction in seasonality within a nine-month period. For any entry above,

$$D^2 = \sum_{i=1}^{9} \left(\frac{\sum_{i=1}^{9} s_i}{9} - s_i \right)^2$$

where s_i represents the i-th month seasonal factor, where the s_i are the nine highest seasonal factors for any year. The s_i have been obtained from Tables B-5 to B-8. If employment tended to be equal in each of the nine highest months D^2 would equal zero. Consequently, a decline in D^2 shows a decline in seasonality within the nine-month period. Because of the nature of the measure, cardinal comparisons between regions or years are not possible. That is, although D^2 for 1965 in Quebec is ten times higher than the corresponding figure in Ontario and the Prairies this does not imply that Quebec is ten times further away from a nine-month year. It permits only the inference that Quebec is significantly further from a nine-month year than Ontario and the Prairies. Similarly, the change in D^2 from 1952 to 1965 for Quebec shows only that Quebec is closer to a nine-month year than it was previously. It does not show that Quebec is three times as close as it was.

*Includes Newfoundland, Nova Scotia, and New Brunswick.

CI — Average of monthly percentage changes in the cyclical and irregular factors;

MCD — Months for cyclical dominance—average number of months needed for a cyclical change to dominate an irregular change.

Table B-9 presents a summary measure of trends toward or away from a nine-month employment year.

In addition to the CPPA seasonality data, a series of seasonal components were computed based on data compiled from returns to the Domin-

ion Bureau of Statistics monthly survey, "Employment and Payrolls". These D.B.S. data represent employees on the payroll for the pay period reported and would include substantially all employees hired or laid off during that pay period. Because of the exceptionally high amount of labour turnover in pulpwood logging, these payroll-based employment figures considerably overstate labour input.

D.B.S. employment data for the pulpwood logging industry were not compiled from 1951 to 1956 and consequently no comparison can be made between the derived CPPA and D.B.S. series for those years. From 1951 to 1956 for east of the Rockies the CPPA series shows a pronounced decline in seasonality. From 1957 to 1960 the series is rising whereas since 1960 there has been a declining seasonality. On the other hand, the derived D.B.S. series shows rising seasonality in Eastern Canada (i.e., in Ontario, Quebec, New Brunswick, and Newfoundland) from 1957 to 1962 with a levelling off since then. On a provincial basis an examination of the two series for Ontario reveals that both exhibit a rising seasonality from 1957 to 1960 and a declining seasonality from 1960 to 1965. However, the trends in the derived CPPA series are much sharper. In the Atlantic provinces both series move very closely together rising from 1957 to 1962 and declining from 1962 to 1965. In the province of Quebec while the D.B.S. series reveals a sharply rising seasonality over the nine-year period the CPPA series is relatively constant.

The difference between the two series for east of the Rockies may be thought of, therefore, as a difference between the two series for Quebec and Ontario. A diligent search of all available information failed to yield any satisfactory cause of the discrepancies between the two series for the two provinces. Turnover rates for the two provinces were studied carefully but do not appear to be the cause of the differences. The inclusion of the Prairies in the derived CPPA Ontario series would seem unlikely to create the sharper trends in the CPPA series as compared with the D.B.S. derived series. Differences in reporting methods may give rise to the differing seasonality trends but this cannot be satisfactorily determined.

Appendix C

LABOUR TURNOVER

The number of persons hired or separated each week per 100 employees on the payroll in Forestry, Construction, and All Industries Surveyed in Canada from 1948 to 1964 is shown in Table C-1. These weekly hiring and separation rates were derived from the published D.B.S. average monthly rates by division by 52/12. The denominator for the D.B.S. rates was the number of people on the payroll for the pay period reported. This figure includes all persons hired or separated during the pay period and thus overstates the true employment level—particularly in the high turnover industries. By inflating the employment figure, it tends differentially to understate turnover rates for high turnover industries.

A provincial breakdown of average weekly hiring and separation rates for the pulpwood logging industry is given in Table C-2. These rates were derived from CPPA weekly labour supply reports, and are not directly comparable with the D.B.S. data in Table C-1. The CPPA weekly hirings and separations were summed for each of the years from 1951-1952 to 1964-1965 and then divided by the appropriately summed average weekly employment figures.

Table C-3 presents provincial data on the ratio of average weekly "quits to be replaced" to the average weekly employment on company limit operations. These data have been calculated from CPPA weekly labour supply reports in the same manner as Table C-2—weekly quits were summed for each of the years and divided by the appropriate average weekly employment figures. The "quits to be replaced" data include some (possibly only a few) firings for cause. They do not represent a pure voluntary separation rate both because of the inclusion of firing for cause and because some voluntary quits need not be replaced and therefore do not appear in the numerator.

Table C-1. Average Weekly Hiring and Separation Rates for Forestry, Construction and All Industries Surveyed, Canada, 1948-1964

	Hiring Rate			Separation Rate		
	All Industries	Forestry	Construction	All Industries	Forestry	Construction
1948	1.8	8.2	4.3	1.8	8.8	4.1
1949	1.6	7.8	3.9	1.6	8.0	4.0
1950	1.7	9.8	4.0	1.6	9.0	3.8
1951	1.8	9.9	4.2	1.8	9.7	4.0
1952	1.7	9.4	4.1	1.7	9.8	3.9
1953	1.6	8.6	3.9	1.6	8.8	4.0
1954	1.5	8.8	3.9	1.5	8.5	4.0
1955	1.6	8.7	4.1	1.5	8.5	4.0
1956	1.7	9.1	4.2	1.6	9.2	4.0
1957	1.5	8.8	3.9	1.6	9.7	4.2
1958	1.4	8.4	3.9	1.4	8.1	4.1
1959	1.5	7.9	4.0	1.4	7.7	3.9
1960	1.4	8.0	4.0	1.5	8.3	4.2
1961	1.4	7.5	4.0	1.4	7.3	4.0
1962	1.4	7.0	3.9	1.4	7.1	3.9
1963	1.4	7.0	3.8	1.4	7.0	3.8
1964*	1.5	7.5	4.2	1.3	6.8	3.2

*Eight-month average, January-August.
SOURCE: Calculated from D.B.S., *Hiring and Separation Rates in Certain Industries.*

Table C-2. Average Weekly Hiring and Separation Rates on Pulpwood Logging Company Limit Operations, East of the Rockies and Regions, 1951-52 to 1964-65

Year*	Newfoundland and Nova Scotia		New Brunswick		Atlantic**		Quebec		Ontario and Prairies		East of the Rockies	
	H	S	H	S	H	S	H	S	H	S	H	S
1951–52	13.6	13.0	15.2	14.6	14.2	13.5	15.2	15.1	10.3	10.1	13.8	13.6
1952–53	13.0	10.3	16.8	15.1	13.8	11.3	14.6	15.0	8.5	8.6	13.2	13.0
1953–54	13.4	13.0	15.9	16.0	13.9	13.6	14.3	14.2	8.5	8.1	12.8	12.6
1954–55	14.1	12.3	13.0	14.5	13.8	12.9	13.4	13.2	6.8	6.8	11.9	11.6
1955–56	13.0	12.0	12.9	14.6	13.0	12.6	14.1	13.6	6.7	6.0	12.3	11.8
1956–57	13.0	11.1	12.4	13.4	12.8	11.8	14.5	14.4	8.1	7.9	12.6	12.3
1957–58	11.9	11.4	15.6	15.1	13.0	12.4	15.3	15.9	6.6	7.5	12.6	13.1
1958–59	13.2	15.8	13.1	14.3	13.1	15.3	12.9	12.9	5.3	5.8	11.1	11.6
1959–60	11.7	9.0	14.3	14.3	12.5	10.7	12.6	13.0	5.4	5.7	11.0	10.9
1960–61	9.1	11.7	16.2	16.0	11.0	12.9	14.3	14.0	4.6	5.2	11.6	11.9
1961–62	11.9	13.6	14.3	12.6	12.6	13.2	13.0	13.4	5.0	5.0	11.1	11.5
1962–63	11.5	10.9	12.8	13.6	11.9	11.7	13.5	13.5	4.6	5.7	11.0	11.2
1963–64	7.7	8.1	13.8	12.9	9.7	9.7	14.4	13.7	4.5	4.6	11.1	10.7
1964–65	7.2	9.4	11.2	10.6	8.8	9.9	13.7	14.0	3.8	3.6	10.3	10.6

*June-May year.
**Includes Newfoundland, Nova Scotia and New Brunswick.
SOURCE: Calculated from CPPA weekly labour supply reports.

Table C-3. Ratio of Average Weekly "Quits to be Replaced" to Average Weekly Employment, Pulpwood Logging Company Limit Operations, East of the Rockies and Regions, 1951-52 to 1964-65

Year*	Newfoundland and Nova Scotia	New Brunswick	Atlantic**	Quebec	Ontario and Prairies	East of the Rockies
	(per cent)					
1951–52......	7.2	3.7	6.1	8.2	6.3	7.4
1952–53......	6.0	1.1	4.9	5.3	1.9	4.5
1953–54......	5.1	0.6	4.1	3.8	2.4	3.5
1954–55......	5.8	0.7	4.5	3.9	1.4	3.5
1955–56......	5.6	1.1	4.5	7.1	1.8	5.4
1956–57......	4.3	3.8	4.1	7.2	2.8	5.6
1957–58......	0.8	0.5	0.7	5.0	1.6	3.4
1958–59......	4.5	0.5	3.5	2.8	0.9	2.4
1959–60......	2.3	0.1	1.6	4.1	0.6	2.8
1960–61......	3.1	1.5	2.7	4.2	0.5	3.1
1961–62......	0.9	0.4	0.7	2.9	0.4	1.9
1962–63......	2.4	0.5	1.8	3.3	0.2	2.2
1963–64......	0.1	1.8	0.6	4.3	0.4	2.6
1964–65......	0.0	0.4	0.1	4.4	0.5	2.7

*June-May year.
**Includes Newfoundland, Nova Scotia and New Brunswick.
SOURCE: Calculated from CPPA weekly labour supply reports.

Appendix D

TRENDS IN PULPWOOD LENGTHS

Trends in pulpwood lengths on company limit operations east of the Rockies from 1957-1958 to 1964-1965 are given in Table D-1. These data were calculated from statistics supplied by the Canadian Pulp and Paper Association. Firms reporting in the survey were asked to give the length of pulpwood cut on their operations during its movement from the stump to the intermediate landing. Unfortunately, the reporting of this information was not consistent. Some firms quoted wood lengths at the landing with the result that some wood which was hauled from the stump to the landing in tree-length form and was slashed at the landing into short-wood lengths was reported as short wood. Consequently, the proportion of tree-length operations is seriously underestimated and extreme caution must be used in interpreting the trends in short-wood and tree-length in the table.

Reliable industry sources suggest that tree-length operations accounted for about 45 per cent of the company limit pulpwood cut and short-wood operations for about 55 per cent during the 1964-1965 season. Most of the understatement occurred in Quebec and the "Other" provinces. The appropriate figure for tree-length operations in Quebec would be about 40 per cent as compared with the 17 per cent figure shown in the table, and in the "Other" provinces would be about 35 per cent instead of the 4 per cent figure in the table. The 57 per cent tree-length figure for Ontario is understood to be representative of logging operations in that province.

For the 1965-1966 season industry sources suggest that tree-length and short-wood operations each accounted for about 50 per cent of the company limit pulpwood cut.

Table D-1. Trends in Pulpwood Lengths on Company Limit Operations, East of the Rockies and Provinces, 1957-1958 to 1964-1965

Operating Year†	Ontario						Quebec						Other**						East of the Rockies					
	4′	8′	12′	Total Short-Wood	Tree-Length††	Total All Wood	4′	8′	12′	Total Short-Wood	Tree-Length††	Total All Wood	4′	8′	12′	Total Short-Wood	Tree-Length††	Total All Wood	4′	8′	12′	Total Short-Wood	Tree-Length††	Total All Wood
	(per cent)																							
1957–58...	16	56	2	74	26	100	89	2	4	95	5	100	–	–	–	–	–	–	59	24	3	86	14	100
1958–59...	13	52	1	66	34	100	91	2	4	97	3	100	60	3	2	65	35	100	61	17	3	81	19	100
1959–60...	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1960–61...	7	52	*	59	41	100	82	7	2	91	9	100	90	*	*	90	10	100	61	19	1	81	19	100
1961–62...	6	49	*	55	45	100	79	9	7	95	5	100	94	1	2	97	3	100	61	19	4	84	16	100
1962–63...	9	50	*	59	41	100	80	8	6	94	6	100	94	1	1	96	4	100	60	20	3	83	17	100
1963–64...	10	53	*	63	37	100	74	10	2	86	14	100	84	1	*	85	15	100	58	20	1	79	21	100
1964–65...	10	33	*	43	57	100	68	13	2	83	17	100	88	5	3	96	4	100	57	17	2	76	24	100

† May 1 - April 30.
††Includes 16′ wood.
*Less than 1 per cent.
**Mainly Atlantic provinces.
—Data not available.
SOURCE: Calculated from statistics supplied by the Canadian Pulp and Paper Association.

GLOSSARY

Abitibi	—Abitibi Paper Company, Limited, Toronto, Ontario, one of three companies experimenting with the Arbomatik Processor.
Arbomatik Processor	—a multi-process machine which performs two or more of the following functions: limbing, barking, bucking and piling of the bolts of pulpwood, generally, in the landing area.
Barking	—operation by which bark is removed from a tree.
Beloit	—Beloit International (Canada) Limited, builder of the Beloit Tree Harvester.
BPU	—Bombardier-Processing Unit.
Branching	—see Limbing.
Bucking	—cutting tree lengths into logs or bolts of desired length.
Cellulose	—fibers which form the basic constituents of paper.
Chipping	—operation by which tree lengths, log lengths, or bolts of pulpwood are reduced to chip form.
Chokerman	—assembles tree lengths or bundles of logs or bolts in self-tightening loops of wire rope (chokers) which are attached to cable from skidder or yarder for forwarding to the landing.
CIP	—Canadian International Paper Company, Montreal, one of three companies experimenting with the Arbomatik Processor.
CPPA	—Canadian Pulp and Paper Association.
Cord	—a stack cord is nominally 4 feet $\times$ 4 feet $\times$ 8 feet or 128 cubic feet. It usually contains approximately 85 cubic feet of solid wood.

Cunit	—100 cubic feet of solid wood.
Delimbing	—see Limbing.
Diffusion Rate	—speed at which the extent of diffusion is rising.
Extent of Diffusion	—represents the extent of penetration of Arbomatik Processors or Tree Harvesters into a province, measured according to the proportion of the total amount of pulpwood cut by either machine to the province's company limit production.
Felling	—operation by which a standing tree is severed from a stump.
Forwarder	—machine which transports bolts of pulpwood from the stump area to a landing area.
Forwarding	—transporting of bolts of pulpwood from the stump area to a landing area.
Full Tree	—tree with branches and top still attached.
Full-Tree Methods	—varying ways in the full-tree system of pulpwood logging in which full trees, i.e., trees with branches still attached, can be transported from the stump area to a landing.
Full-Tree System	—a system of pulpwood logging where felling only is performed in the stump area and where full trees are forwarded from the stump area to a landing.
Groundwood Process	—making of pulp by the wet grinding of wood blocks. This pulp is used in the making of newsprint and certain wall, bag and wrapping papers.
Koehring	—Koehring-Waterous Limited, Brantford, Ontario, experimenting with Koehring Processor and manufacturer of Koehring Forwarder.
Koehring Processor	—a multi-process machine which fells, limbs, bucks and piles 8-foot wood in the stump area.
Kraft Pulp	—pulp obtained by the Sulphate process of making pulp.

Landing, Final	—point where the long distance movement of pulpwood by rail or water to the mill begins.
Landing, Roadside	—a term often used as equivalent to intermediate landing.
Limbing	—operation by which branches are removed from a tree.
Logging Operation	—the stump to final landing phase of the pulpwood production process (includes river drive where applicable). See Pulpwood Logging.
LRA	—Logging Research Associates, organization which represents the CIP, Abitibi, and Quebec North Shore Paper companies and which is conducting experiments with the Arbomatik Processor.
Operating Hour	—includes machine time and paid idle time. Machine time is the effective time during which the machine is actually running and paid idle time is the machine idle time during which direct labour continues to receive a wage.
Processing	—comprises the operations of felling, limbing, topping, bucking, scaling, barking and chipping.
Pulpwood	—roundwood used in the making of pulp and paper.
Pulpwood Logging	—consists of all operations performed on pulpwood trees from the standing tree in the stump area to the final landing or to the mill in some direct truck hauls or where water transportation is used.
QNSPC	—Quebec North Shore Paper Company, Limited, Montreal, an affiliate of The Ontario Paper Company, Limited, which is experimenting with the Arbomatik Processor.
Scaling	—operation where company markings are placed on bolts of pulpwood for clear identification and individual cutters production is recorded separately for payment.

Short-Wood Methods	—varying ways of pulpwood logging in which short wood, i.e., 4-, 8- and 12-foot pulpwood, can be moved from a stump area to a landing area.
Short-Wood System	—a system of pulpwood logging where the processing operations of felling, limbing, topping, bucking and possibly barking are performed in the stump area and where short wood (4-, 8- and 12-foot pulpwood) is transported from the stump area to a landing.
Skidder	—a rubber-tired or tracked vehicle which drags trees or logs from a stump area to a landing, generally semi-suspended.
Skidding	—forwarding trees or logs from the stump area to the landing, either in full contact with the ground, or semi-suspended, behind a rubber-tired or tracked vehicle (or horse).
Slash_1 (verb)	—to cut tree lengths into pieces or bolts of desired length, generally by powered saw or gang saw at a landing.
Slash_2 (noun)	—branches and top of a tree or trees.
Soda Process	—making of pulp by digesting the wood or other fibers with a solution of caustic soda. This chemical pulp is used to manufacture wrapping paper, and book, magazine and envelope papers.
Stump Area	—area where standing tree is felled.
Sulphate Process	—manufacturing of sulphate or kraft pulp by digesting wood chips with sodium sulphate and sulphide liquor. The kraft pulp is used to a large degree in the manufacture of wrapping paper and paper bags.
Sulphite Process	—making of chemical pulp by digesting wood chips with an acid liquor at a high temperature and pressure. The pulp is used in the production of the highest grades of papers.

Topping	—removal of the top part of the tree which is too small for pulpwood.
Transportation	—movement of wood from the stump area to the final landing, but generally used in reference to the movement between intermediate and final landing or mill.
Tree Harvester	—a multi-process machine which limbs, tops, fells and bunches tree lengths in the stump area.
Tree-Length Methods	—varying ways of pulpwood logging in which tree lengths can be transported from a stump area to a landing.
Tree-Length System	—a system of pulpwood logging where the processing operations of limbing, topping and felling are performed in the stump area and where the tree length is moved from the stump area to a landing.
VFB	—Vit-Feller Buncher.
Woodlot	—an area of land covered with trees where the owner produces pulpwood for sale generally to a pulp or paper mill.

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FIGURE 17. Malak, Ottawa

FIGURE 18. Continental-Emsco Co., Dallas, Texas

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FIGURE 20. Ross Photo, Dolbeau, Quebec

FIGURE 21. Malak, Ottawa

FIGURE 22. Ross Photo, Dolbeau, Quebec

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